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SCIENTIFIC METHOD AND SOCIAL RELATIONS[1]

By B. E. SCHAAR

CHICAGO, ILLINOIS

WITH rare exceptions, society owes a tremendous debt to science. The exceptions are concerned wholly with misapplications of the results of scientific discovery and not with the discoveries themselves.

The immediate task of the worker in pure science, and the term is used with full recognition of the fact that there is no sharp line of demarcation between pure and applied science, is the discovery of new principles, including very broadly in that term fundamental laws, atoms, molecules and their relations to one another and greater refinement of existing knowledge of those subjects. His concern is primarily with the advancement of knowledge *per se*, with satisfying his own curiosity regarding the nature of things, usually with no thought to the practical purposes to which his work may be applied nor to monetary consideration. The worker in applied science, on the other hand, finds himself concerned with application of known principles to the production of commodities which are to be marketed, consequently, also very broadly and with many exceptions his ultimate goal is profit either to himself or to his employer.

The chemist has been able to make a much greater contribution to the welfare of mankind than other scientific men, because his field is fundamental, dealing with matter in its endless variety. Although it is hardly necessary before a group of chemists to mention specifically many of the countless examples where the influence of the chemist is felt either directly or indirectly, some few may be cited in order to indicate the present relation of the chemist to society. These may be grouped broadly into two classes, the first including substances which are utilized directly by the body, such as foods, drugs, cosmetics, etc., and the

[1] Address as retiring chairman of the Chicago Section of The American Chemical Society, September 23, 1932.

second, things which affect the environment, such as structural materials, chemicals, materials used in the manufacture of articles for use or ornamentation, processes, etc.

Foremost in its effect on society would have to be placed the preparation of medicinals for the prevention and cure of disease, including the discovery and manufacture of specifics as well as the isolation or synthesis of glandular secretions. Human reactions are so closely bound up with glandular secretions that it is hardly an exaggeration to say that those reactions themselves may ultimately be resolved along chemical or physico-chemical lines. That, however, is a task for the biochemist of the future.

The chemist's contribution with respect to foods is not mentioned as of primary importance because a bounteous nature provides food for all forms of life without man's assistance. However, there is hardly a food to-day, either raw or prepared, which has not at some stage in its growth or preparation been subjected to some sort of treatment or process dependent upon chemical investigation. One need only mention fertilizers, fungicides, insecticides, preservatives, the analysis of foods for their dietary value, vitamins, etc., to realize the scope of that influence.

On cosmetics, including in that term all toilet articles as well, we need not dwell. They are not an unmixed blessing, although painted in brilliant colors.

With respect to raw materials, not only are natural products made available or improved by chemical treatment, but new ones are continuously being created by the chemist which are better than natural products or are designed for particular purposes which no natural products can fill.

Production costs are lowered by the application of chemical knowledge. In consequence, a vastly wider distribution is possible. Items which formerly were considered luxuries have now become necessities of life. Rarities have become common articles of commerce. Elements and chemicals heretofore unknown have become instruments for the alleviation of suffering or the prolongation of life. It is impossible to estimate what effect just the few generalities which have been mentioned have had on our economic status and habits of life. To mention only a few obvious facts: Hours of labor have decreased in practically one generation from an average of six full days of ten to fourteen hours each to five and a half days of eight hours, and promise to be still further reduced. Crushing human labor in field, factory and home has been relieved by machines. Mobility has greatly increased and intercommunication between nations has attained a facility undreamed of until very recent years. Infant mortality has decreased about one half. The average span of life has increased approximately ten years. To ascribe all this to the chemist is, perhaps, a bit too self-laudatory, but since chemistry is the fundamental science with respect to matter and its manifold transformations, it is entitled to the lion's share of credit, as it must also bear the brunt of responsibility when its findings are misused, particularly so when its disciples, chemists, lend their aid either actively or passively to such misuse. It may be objected that most of these benefits are properly due to development of arts or engineering rather than chemistry, but we can not get away from the fact that fundamentally both engineering and the arts owe their development to the application of chemistry in one form or another.

To a lesser extent our sister science, physics, must share in whatever glory there is, as well as criticism. But since physics has left the earth for parts unknown and many of our leading physicists have gone to the mourner's bench, perhaps it should be left out of consideration entirely where simple human affairs are concerned. Or perhaps chemists should be absolved from responsibility altogether, since the universe has been reduced by physicists to systems of physical waves or metaphysical thought, with a tendency to annihilate matter entirely. The philosopher's stone of the alchemist is still being sought, but under a different guise. The eternal quest for certainty has been resolved by Heisenberg and others into the certainty of uncertainty.

In their respective fields, the biologist, the bacteriologist and every other scientific man, as well as the chemist and physicist, is each making his contribution to the improvement of the condition of mankind. They are making it possible for men to live and enjoy life rather than to simply exist. Whether this condition is actually realized is beside the question. The possibility is there. If it is not realized, it is due to man's stupidity or to the scientific man's failure to follow up his work and see that proper use is made of it.

The day of brilliant individual achievement in scientific work is nearing its end, if indeed it has not already disappeared. The ultimate development of science as well as control of social forces must be sought in collective effort. This apparently is contradicted by the existence of an Einstein, now at the height of his career, but in reality Einstein himself is rather a proof than a denial of its validity. Without the prior work of Minkowski, Fitzgerald, Lorenz, Michelson, Morley and a host of others, there is little doubt that Einstein could not have developed his relativity theories. Einstein is a thinker, a theorist, a scientific philosopher, not an experimenter or laboratory worker. Previous experiments, particularly the failure of one, that of Michelson and Morley, to

detect any motion of the earth relative to the ether, were used by him as bases for his speculations, and in that sense the prior workers were collaborators of his in the development of his theories.

From the standpoint of original, unaided, individual effort the contributions of early scientific men, from Copernicus down to about the middle of the last century, were far more significant than those of later workers. There were more fundamental facts and theories to be disclosed and less prior work upon which to draw. Whitehead, in "Science and The Modern World," points out that Galileo's famous experiment of dropping bodies of different weight from the leaning tower of Pisa could have been performed at any time during the preceding five thousand years, whereas Michelson's interferometer ether drift experiment could not have been made earlier than it was. Neither scientific thought nor apparatus had been developed sufficiently to make even the conception of such an experiment possible.

In this respect the Raman effect is interesting. The scattering of light in a liquid, the illumination of all the water in a vessel, for example, when light strikes the surface, might have been observed at any time, without instruments. The frequency of the scattered radiation could have been measured after Kirchhoff and Bunsen developed the spectroscope about the middle of last century, but it remained for Raman to do this in 1928, when he discovered that it differed from the frequency of the original beam of monochromatic light. Had Bunsen or Kirchhoff made this observation it would merely have been an interesting scientific fact. When Raman announced it, it was literally pounced upon as of tremendous significance. It was soon discovered that the frequency of the secondary radiation was due to the nature of the molecules concerned in the scattering, that the difference in frequencies between definite lines in the scattered and incident light is the same as the frequency of vibrating atoms in the molecule. Consequently, Raman spectra are useful in determining molecular structure as well as for qualitative identification of compounds. The literature to-day is flooded with articles on Raman effect. Raman's discovery is significant only because developments in the conception of atomic and molecular structure in the last few years have made its interpretation and application possible.

Numerous other comparisons might be made, based primarily upon the thought that early experiments were controlled repetitions of common experiences as opposed to modern physical experiments, cosmic in scope or in the field of chemistry and molecular physics, sub-microscopic, wholly dependent upon accepted facts and applications of known methods. A modern paper, even on a comparatively simple item in any experimental science, is always accompanied by a long list of references to the literature, work which is accepted by the writer unless it is his intention to question the validity of the prior work, in which case it is repeated. This acceptance of verified scientific data is quite different from acceptance of social institutions or economic systems, which will be considered later. Obviously, there would be no advance in any science if every worker set out to repeat and confirm in detail for himself each fact upon which his particular work is based. It is difficult to conceive of an isolated fact being discovered to-day which is independent of previous experiments or thought.

There was a time when the store of human knowledge was so limited that it was possible for an exceptional individual to be an outstanding authority in many fields. Aristotle, philosopher, naturalist, biologist and scientific man within the limits possible for his time, set a standard for organization of knowledge which compares favorably with current practice, but development of experimental science was retarded for almost 2,000 years by acceptance of his work as finality until the historical revolt of the sixteenth and seventeenth centuries ushered in a new era. A greater figure, perhaps, was Leonardo da Vinci, one of the most brilliant geniuses of all history. His eminence as artist and sculptor during his lifetime was almost equaled by his fame as physician, architect, engineer and inventor. As scientific man and naturalist he was a pioneer antedating Bacon by a hundred years. However, his work, while basically sound, was almost wholly ineffective either in his own day or in influencing subsequent development because the world was not yet ready to proceed along the lines he mapped out, and he founded no "school" to carry out or keep alive his ideas. It is stated that he propounded a theory of tremendous age for the earth as evidenced by fossils, to the faculty of the University of Padua, which was received with respectful reservations as to his sanity.

Since then scientific knowledge has increased by leaps and bounds, until at present there is literally an avalanche of data continuously being ground out in every conceivable branch of science. It is no longer possible to consider the individual sciences as entities. Each has been divided and subdivided and each subdivision still further specialized with decided overlapping into other sciences. Minute fragments of knowledge a few years ago have been and are being expanded into separate branches of science, with these in turn undergoing similar development, each subdivision yielding a whole literature. A book in

three volumes, entitled "Chemical Embryology," was recently announced, consisting of 2,000 pages with 241 of bibliography, listing about 7,000 titles of references. Libraries are being written on atomic and molecular structure and even this highly specialized topic is so vast that it is necessary for a worker to confine himself to one small fraction of the subject if he expects to make any contribution at all. One is reminded of photographs of the heavens which are shown to impress one with the immensity of space. First a portion of the sky is shown as seen by the naked eye. A small square of that, apparently containing only a few stars, is viewed through a telescope and enlarged to the same size as the original picture, and that portion looms up with as many stars as the original. The process is repeated with more powerful telescopes and each time what appeared almost as blank space or nebulous matter is revealed as millions of suns, or other galaxies which await the making of larger telescopes for further resolution. The sciences are in quite the same category. There does not seem to be, at least at present, any limit to the possible development of any science within itself or in combination with other sciences. Advance in science as in invention proceeds in geometric ratio.

This extreme specialization, while highly necessary for progress, presents a serious problem. Few individual scientific men are capable of encompassing their entire special science. Masters in more than one are rarer. A Bertrand Russell is not produced in every generation. As astronomer, physicist and philosopher, his contribution to the science of human relations is proportionate to his mastery of these subjects.

The necessity for close application and extreme specialization has very serious drawbacks with respect to the coordination of the individual scientific man and society. To quote again from Whitehead in his discussion of the professionalizing of knowledge, "It produces minds in a groove. Each profession makes progress, but it is progress in its own groove." He adds: "The leading intellects lack balance. They see this set of circumstances, or that set; but not both sets together. The task of coordination is left to those who lack either the force or the character to succeed in some definite career. In short, the specialized functions of the community are performed better and more progressively, but the generalized direction lacks vision. The progressiveness in detail only adds to the danger produced by the feebleness of coordination." The specialist falls short of effectiveness outside his specialty, because of the circumscribed area in which he is compelled to operate. He is frequently not even concerned with the larger application of his work to the parent science, still less with its application to other sciences, and rarely, if at all, with its possible effect on humanity. Lemon wrote in "The Nature of the World and Man," "The physicist is not concerned with directly benefiting society which perhaps already is in possession of more Godlike powers than it can intelligently use." The million wild horses of Stuart Chase are as nothing compared with the dangerous potentialities of children of the brains of scientific men, abandoned at birth. The need for a coordinator is indicated, or paradoxically, a specialist in generalization. To an extent our pure philosophers and our physicist-philosophers occupy this position, but only in its more speculative aspects. The real need is here and now.

In our industrial research laboratories the problem is solved for particular ends. Research is planned for a definite object, improvement of a process, lowering of cost of production, or development of new products. Should research in "pure" science be required it is usually followed only so far as it has a bearing on the industry.

Recognition of benefits to be derived from directed research is evidenced by establishment in most countries of institutes, particularly for medical research, and many cooperative institutes of various industries designed for the solution of special problems common to all members of a particular industry. Not only are the advantages of directed research recognized, but it is becoming increasingly evident that many problems require cooperative effort of workers in many branches of science for their ultimate solution. The concluding paragraphs of the report on "The Future Independence and Progress of American Medicine in the Age of Chemistry," in the making of which Dr. Abel and Dr. Stieglitz collaborated with others, are most significant: "The problems of life and health, as safeguarded by medicine, are in their very nature so complex that rapid successful advance demands the *cooperative effort of scientists of the highest type,* each a leader in his field and deeply interested in the correlated fields of science, willing to submerge his talents and his effort in the common problem for the common good."

This is a logical extension of the scientific method to reach a definite goal by concerted effort. Individual effort has thus far failed to produce the desired result in the particular investigations being pursued. Eventually the result might be attained by slow stages through efforts of scattered workers throughout the world, but the probability is that cooperative research will be much quicker if the result is attainable; and who would have the temerity to-day to say that any end consistent with natural laws is not possible of attainment?

Science has no obvious or immediate social obligations similar to those incumbent upon medicine or law. Society expects and receives, to greater or less extent, from these professions something beyond their practice for personal profit. But up to the present society has made no such clear demands upon science, accepting its findings much as it does industrial achievements, with this profound difference—the successful business man is looked up to for advice and guidance in matters quite remote from business, while the scientific man, who by his training should be better qualified, is not consulted, even as to the social uses of the very creations of his particular ability.

There are certain fields in which even scientifically trained persons frequently consider themselves competent judges, notably politics, government, religion, economics and one phase of biology. Their opinions in these matters, excepting those of unbiased specialists, are little more than prejudices. It is no coincidence that the opinions expressed by such persons are usually the prevailing opinions, usually a defense of current institutions, an obeisance to the god of things as they are. J. B. S. Haldane recently said: "A large proportion of mankind, after a more or less human childhood, becomes almost unteachable. They are sure of everything. They know what is right in politics, religion, art and human behavior." Recognition of the part which preconceived notions, prejudices and habits of thought play in human relations would go a long way toward rectifying many of the ills of humanity. General acceptance of this fact by those in position to apply it practically would enable us to make a fresh start in attacking the problems of human relations, freed from the thraldom of custom. It is here that the scientific man can make his greatest contribution.

The scientific method has been variously defined. Perhaps the simplest statement would be that it consists in finding out, by observation, reference to the literature or actual experiment, all ascertainable facts pertaining to a given situation. An indispensable adjunct is the ability to properly interpret the facts after they have been found. Up to the present the method has had little application outside the laboratory. In the larger field of human relations the main reliance has been upon habit and custom, upon a child-like acceptance of the infallibility of methods of past generations, even though those methods were arrived at without scientific analysis of the facts, and, of course, without our present ability to ascertain the facts. It is a most curious inconsistency that the very scientific man who is credited with the basic responsibility for our present state of civilization, at least so far as creature comforts are concerned, should not be thought of by those in power for at least some slight contribution in the matter of social control.

There is much talk in this country now about the advisability of establishing an economic council along the lines of the board appointed during the war. A bill for the creation of such a council was presented in the Senate, which provided that the members shall be selected from organizations representing "the industrial, financial, agricultural, transportation and labor interests of the United States." Surely, on such a council, directly affecting the welfare of every individual in the country, scientific men could make a tremendous contribution. There is not one of these interests or any other interest that is not vitally affected by scientific endeavor, but is there any recognition of this fact? It apparently occurs to no one in authority that, aside from laying the foundation upon which our particular structure rests, the scientific man, by the application of the very method which has enabled him to subdue, or at least modify nature, ought to be able to point a method of approach for the better ordering of man's interrelationships. For, after all, that is the sole purpose in the creation of an economic council.

The scientific man must be largely blamed for this situation, for does he not, outside his laboratory and the productions thereof, himself forsake the scientific method? Thus in the social field we find him in the same category with those who are incapable of forming basically sound opinions. No better example of this can be cited than the deplorable record of scientific men in all the warring countries during the last war. Nothing was done outside their specialties which could have been distinguished from the actions of the most unlearned or unscientific, unless perhaps it was the greater vindictiveness of the scientific man. What more shameful spectacle was witnessed behind the battle-lines than the irrational hatreds exhibited by both individual and organized scientific men in all countries. There is no need to be specific. The shame is on all alike. Instead of being the leaders themselves, which their training should have made them, they permitted themselves to be led, or even driven like sheep, by intellectually inferior politicians and industrialists in every country. And the greater pity is that even now, when more sober judgments prevail, despite profound efforts at greater international understanding and agreement, we still find many scientific men actively opposing such efforts. The reason is easy to find. With respect to his social attitudes, the scientific man is no different than one without his training. In economics it is the same. In a word, in these matters he is no longer the scientific man. He becomes emotionally one of the mass with its prejudices and uncritical acceptance of prevailing ideas.

In the last analysis, the matter of social control is the most important task to which any discipline can dedicate itself. However, it is just at this point, when

the method of the scientific man is of such significance, that he apparently forgets his training, accepts without question prevailing opinions and becomes a tool in the hands of others for maintaining the status quo. Had this state of mind obtained with respect to purely scientific matters there certainly would have been no progress. With some exceptions, such as Priestley's opposition to the rejection of the phlogiston theory, or Berzelius' tenacious espousal of dualism, or the arguments against Young's wave theory of light, the scientific attitude is one of continuous inquiry and open-mindedness with respect to change. Newtonian mechanics, firmly intrenched for two hundred years, has been changed. By the accumulation of evidence extending over a half century, sufficient data were amassed so that Einstein in 1905 could definitely state wherein it was insufficient and so modify it as to make it conform to cosmic as well as earthly events. Promptly, a mad scramble was on to verify Einstein. To date this has resulted in his vindication, only to have Einstein himself deny the necessity for one of his earlier assumptions, this also as the result of further experiment. Bohr's atom displaced previous atomic models, was accepted, albeit with many reservations, played its part for a while, finally to yield to newer ideas. Whether or not we shall ever have a picture of the atom which is accepted by all who are competent to judge is at least doubtful in the current state of our knowledge. The point is simply that in scientific work there is no blind adherence to previous conclusions. There is an open-mindedness here, and a readiness to discard outworn vehicles, which oddly enough is not reflected even by the scientific man in human relations. New ideas, customs and even morals are accepted eventually, but these in their turn are clung to just as tenaciously as were the old. There is resistance to change which is thoroughly unscientific.

The kinetic theory of gases postulates molecular immobility at absolute zero. Carrying the idea over, one might say that the absolute zero in intellectual effort is immobility with respect to social institutions, a conviction that the present order is the best of all possible orders, any change in which must be resisted by every available means, even though that order has been distilled from a benighted past. Absurd as this appears in the light of present conditions, it nevertheless is the attitude of a sufficiently powerful number of persons in positions of leadership, either political or economic, to make the application of a scientific method of approach extremely difficult. And yet this is precisely the method of approach that must now be made. More subtle problems, if not more difficult, have to a greater or less extent been successfully attacked by the scientific method. The material is at hand. History, the record of past experiences, needs interpretation in the light of present knowledge. By slow changes, often imperceptible, change does occur —change is perhaps the most constant thing in life— and now, if ever, is the critical time of application of the scientific discipline. Of course, there must be healthy skepticism toward new ideas as well, subjecting such ideas to the same sort of rigorous investigation that characterizes always the scientific attitude.

A great deal has been written recently about the advisability of curtailing scientific effort, on the theory that a holiday in scientific discoveries and their application is desirable so that society can catch up—can overcome the lag between discoveries and their proper uses in the social scheme. Such a discussion is purely academic in this country at the present time. Scientific progress can not be halted nor is it desirable that it should be. The real need is for an extension of the scientific method into fields where it is not now applied, particularly in the fields of economics and human relations. And who should be better qualified to contribute to that extension than the scientific man himself? Usually proposals to alter the present order are met with the statement that you can not change human nature. To accept this is to dehumanize human nature and relegate it to the plane of instinctive behavior of animals and insects. Human nature is human simply because it can be changed. It is changed continuously from babyhood on, and in the past few decades particularly, scientific methods of control, physiological, psychological and the like, have profoundly modified individual behavior. However, our prejudices and inertia to change where social relations are concerned have not been given the same analysis and treatment. Economic "laws" are cited which must not be tampered with, as though these so-called laws were something fundamental in nature like physical laws, instead of being the result of conditions imposed by mankind. Such arguments are used with greater and greater vehemence to-day to prevent any change in a system which periodically blows up and has brought us to our present condition, the seriousness of which most probably has been increased by the fact that the major contribution of science to our economic order has been centered on materialistic advancement almost to the exclusion of directive control. Depressions have occurred at fairly regular intervals for the past hundred years or more. Consequently, it is assumed that it is an economic law in operation. No doubt it is an inevitable result of our system of economics, but wouldn't it be the course of reason to attempt to change that system so that these periodic upheavals would be impossible? Instead, we wait for something to happen—nobody knows what—and eventually prosperity must return,

how or why we do not know, when all the hardships and heartaches of the depression will be forgotten, the obvious lessons as well, only to go through precisely the same ordeal when the next collapse occurs. This is sheer stupidity. It is just as stupid as though the cylinder head of an engine were to blow off periodically, and each time it is put back exactly as it was before without attempting to find out the cause, whether more bolts were required or different material or a better method of combustion, or different fuel, or perhaps the whole engine needed redesigning.

The condition in which the world finds itself to-day requires more than the some sort of blind faith that has served in the past. Our industrialists have failed us; our bankers and banking system have proved woefully inadequate; our statesmen and politicians have failed utterly, if they have not indeed wilfully underestimated the magnitude of the disaster. In the face of one of the most serious economic breakdowns the world has ever known, prohibition is the greatest concern of our two major political parties. It would be amusing were it not so tragic. Even our profit system, that much-vaunted motivating force, the alleged life blood of the capitalistic system, has failed to prevent this calamity. No subtle operation of "economic laws" is going to evolve order out of the chaos in which we to-day find ourselves. Much less can we expect them to effect any modification in the underlying causes of our present condition. Whatever is done must be done by deliberate thinking and planning for a more rational, equitable and secure ordering of society. And to whom shall we look for guidance? Ordinary prudence would say most certainly not to the same sources, industrialists, capitalists or statesmen who have so clearly demonstrated their ineffectiveness. Neither can we expect our scientific men, acting as individuals, uncritically accepting the present order as finality, to be of much assistance. Nor is it very likely that a Moses or a Messiah will suddenly arise in our midst. It is rather a method than a superman that is required. As previously stated, that method is the scientific method, used with such remarkable success in the laboratory, which must somehow be applied to economics, government, international relations and human affairs in general. And it is to our leading scientific men in all branches, including the social sciences, working cooperatively, that we must look for the application of that method.

To summarize briefly the points which I have attempted to make:

(1) The extreme specialization required in order to make any contribution to a particular science has resulted in a lack of coordination between scientific discoveries and their social uses.

(2) The accumulation of scientific information is so vast that it is impossible for a single individual to encompass any one science *in toto*.

(3) Reliance upon the findings of prior workers in a particular field is essential to progress. Even the work of an Einstein can not be considered individualistic, since it rests upon the discoveries of many past or contemporaneous scientists.

(4) It is recognized in some fields, particularly in medical research and in certain industries, that many problems require the cooperative effort of workers in several branches of science for their ultimate solution.

(5) The scientific method which has resulted in such strides in all branches of science and which promises so much more when used cooperatively, should be applied to human relations, national and international.

(6) In our present social order, the greatest progress has been made in materialistic development through technological applications of scientific data, but in human relations there has not been the slightest employment of the scientific method. Instead there has been stubborn resistance to change which is thoroughly unscientific.

(7) The scientific man, best fitted by training and experience, should lead the way in the extension of the scientific method to human relations and help direct the cooperative effort for the solution of the problems involved. Preconceived ideas and prejudices must be discarded. Human relations must be studied in the same manner as physical problems. Open-mindedness must prevail. In the light of the findings, a better order of living than obtains to-day will result.

THE AGE OF METEOR CRATER

By Professor ELIOT BLACKWELDER

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THE noted astronomer, Arrhenius, is said to have declared that Meteor Crater is the most interesting spot on earth. Although others may not concur in that opinion, it is certainly a fact that Meteor Crater[1] has aroused the wonder and interest of the many who have visited it, and has already called forth more than thirty-five papers describing its peculiarities and explaining its origin. Having spent a few days examining the crater in the spring of 1930, I venture

[1] Situated on the plateau of northern Arizona, about 20 miles west of Winslow. Also called Coon Butte.

to set forth some facts and opinions which seem to bear particularly upon the age and evolution of the crater as it now exists.

For the benefit of those readers who may not be familiar with the previous reports, it may be explained that Meteor Crater is an elliptical pit, about three quarters of a mile long and some 600 feet deep, in the surface of the Arizona plateau between Flagstaff and Winslow. It is surrounded by a circular ridge or parapet that rises about 130 feet above the plateau. From its crest this slopes gently outward but steeply inward to the crater. The latter penetrates the full thickness of the Kaibab (Permian) limestone and is bottomed in the massive gray Coconino sandstone, both of which are nearly horizontal throughout the district. Although Gilbert,[2] followed by Darton and others, surmised that the crater may have been produced by an explosion of steam from a buried volcanic intrusion, it is now the consensus of opinion, which the writer believes to be amply justified, that it was made by a meteoric projectile, or bolide, striking the earth from outside at high velocity and producing an appropriate explosion beneath the surface. This view is confirmed by many remarkable and almost unique facts, which have been fully set forth by Barringer[3] and others.

By sinking shafts and drilling holes, explorers of the crater, led by D. M. Barringer,[4] have shown that the original hole is now partly filled with débris. Some of this is talus-stuff which has rolled down from the surrounding cliffs and alluvial fan material washed in from the same source. In the bottom there is also a considerable thickness (about 90 feet) of evenly stratified lake deposits, indicating the former presence of a perennial body of water. This rests upon a chaotic mass of rock flour and debris, the exact origin of which is uncertain. The total filling is apparently about 700 feet deep in the center, but of course it thins out on the surrounding slopes so that in the adit on the south side the talus is only 60 feet thick.

The rock strata encircling the crater, although gently bent upward, are not, so far as observed by the writer, unusually crushed or fractured, and hence we do not appear to see in them the effects of the actual impact. The distribution of large blocks of the Kaibab limestone in all directions around the crater to distances of one mile or more from the brink is consistent with this view. In that case one may infer that finer material in large quantity was carried much farther before it settled out of the air.

Like most of the surface of the Colorado plateau, the vicinity of Meteor Crater is a region of erosion rather than of deposition. Aside from some thin and discontinuous drifts of windblown sand, there are in fact practically no sedimentary deposits in the vicinity. Erosion is carried on chiefly by the wind but partly by temporary streams of water. The process of solution assists to a slight extent.

Deflation is favored by the open and exposed situation of the crater on a nearly treeless plain, by the generally dry condition of the porous soil and by the friability of the red sandstone (Moencopie formation) which immediately overlies the Kaibab limestone. Near the crater the sandstone has been largely worn away. The work of deflation is indicated by the intricately etched forms of the sandstone outcrops, by the bodies of reddish sand in hollows here and there and by the presence of a deflation armor on the crater rim itself, as will be described later. A view of the locality from an airplane shows also that the surface is largely of the sort left by deflation, but with minor ravines eroded by streams.

The work of water rills is more clearly indicated, because streams work along lines and therefore make distinct ravines or gullies. In general, the porosity of the surface material and the aridity of the region are unfavorable to the development of streams. However, in the occasional sudden downpours of rain, which in this region come only a few times in a decade, much erosion may be done in a few hours. In the intervening times, when streams are inactive, the wind tends to fill the erosion channels with drifted sands. The inner slope of the parapet, being steep, is well furrowed with short shallow ravines, but the gentle outer slope is much less marred in this way. In view of the readiness with which rain is absorbed by the porous material instead of running off over the surface, the general flatness of the plateau is a hindrance to rapid stream erosion.

As it exists to-day the crater rim is only the remnant of the original cone of explosion after the erosive processes have removed what they could. A casual examination of the surface of the parapet gives the misleading impression that it is composed largely of blocks and finer débris of the Kaibab limestone and pieces of sandstone. Pits, trenches and shafts that have been dug, especially on the south and southeast sides, show on the contrary that it consists very largely of a white flour-like material which resembles the purest volcanic ash in general appearance, but is in fact pulverized quartz. As shown by Barringer[5] and

[2] G. K. Gilbert, "The Origin of Hypotheses, Illustrated by the Discussion of a Topographic Problem," SCIENCE, n. s., Vol. 3 (1906), pp. 1–13.

[3] D. M. Barringer, "Coon Mountain and its Crater," *Acad. Nat. Sci. Phila. Pr.*, Vol. 57 (1905), pp. 861–886.

[4] D. M. Barringer, "The Geology of Coon Butte," SCIENCE, n. s., Vol. 24 (1906), pp. 370–371.

[5] D. M. Barringer, "Further notes on Meteor Crater, Arizona," *Acad. Nat. Sci. Phila. Pr.*, Vol. 66 (1915), pp. 556–565.

others, this quartz powder was derived from the pulverizing of the Coconino sandstone at the time of the impact. However, it is now everywhere concealed by a thin layer of heterogeneous débris consisting largely of blocks of limestone ranging from small fragments up to masses weighing 4,000 tons or more. It seems highly improbable that at the time of the explosion the expelled material would settle in this arrangement. On the contrary, the large heavy pieces would tend to come to rest sooner, and much of the fine dust floating in the air would have settled more slowly and would thus have formed the bulk of the upper layer. However, if one introduces the factor of deflation, the existing conditions are readily explained, for the wind searchingly removes all fine material that is not protected, and thus the scattered larger fragments of limestone and sandstone gradually become concentrated into a protective layer against which the wind is powerless. This constitutes the familiar deflation armor or desert pavement which is highly characteristic of arid regions the world over.

If this is the correct interpretation of the present structure of the parapet, it indicates that between the date of the explosion and the present time, the wind may have removed a large part of the original accumulation and perhaps more than half of it.[6] It has been calculated by Tilghman[7] that the débris now represented in the parapet would, if replaced in the crater, fall short, by millions of cubic yards, of filling the cavity. The difference may well have been removed by deflation and stream erosion.

The age of the crater has been discussed by previous writers, but the evidence has been considered very scanty. The stories of legends among the Indians regarding a great catastrophe may probably be dismissed as having little weight, for it is improbable that traditions of such matters would last at best more than a few centuries among such primitive tribes. A minimum age of 700 years is indicated by the fact the growth-rings on large cedars, a few of which are scattered about the parapet, show that no important topographic change has taken place in that space of time.

It was supposed by Barringer[8] that the crater was formed not more than 2,000 to 3,000 years ago. On the basis of the effects of erosion Tilghman[9] favored an age of not more than 10,000 years and probably less than 5,000. There are many facts, however, which indicate a much greater age.

The lake deposits in the bottom of the crater, shown by drilling to be 70 to 90 feet thick, comprise stratified sand and quartz flour with many lacustrine gastropod shells and diatom frustules. This is interbedded with platy fresh-water limestone, lignitic beds, diatomite and a single layer of rhyolitic ash ¼ to 3 inches thick.[10] The characteristics of the deposit are such as to indicate a body of water of many years' duration, rather than a seasonal pond or playa. This in turn suggests a climate distinctly cooler or more humid than the present one, for there has been no pond in the crater since it first became known to white men. At present the water-table is about 200 feet below the floor of the pit, whereas during the presence of the lake it must have been somewhat above it.

The bed of volcanic ash is plainly the record of an explosive eruption somewhere in the southwestern arid region. No such eruption is known to have occurred since Pleistocene (late glacial) times. If the age of this shower is ever determined it may afford important evidence regarding the age of Meteor Crater. So far as our present knowledge of these lake beds goes, they suggest the last glacial age of the Pleistocene period rather than any more recent time.

Both upon and beneath the lake beds wedge-shaped alluvial deposits were built out by streamlets descending the steep crater slopes. The lower fans are said by Tilghman[11] to extend out under the lake deposits, although not to the center of the crater, as indicated by exploration in shafts and drill holes. The upper fans are still in process of formation. They consist largely of brown sand exactly like the material now being blown over the surface of the plateau. Some of this is trapped in the crater and has been washed down the slopes in times of rain. A layer of brown sand said to be about 10 feet thick has been spread over the lake deposits, probably in this manner. The advance of these fans is appropriate to a drier climate, with occasional sudden rain storms, as at present.

Most of the limestone blocks upon the parapet are deeply cavernous and corroded by the effects of solution. As this process works rather slowly in an arid climate, the advanced stage of solution pitting indicates a long time. On moraines of the last glacial epoch near Provo, Utah, and elsewhere in the Rocky Mountains, the limestone boulders are much less

[6] In this connection Barringer said, "there can be no doubt that enormous quantities of the finely divided rock flour have been blown away from the slopes by the violent winds . . ." D. M. Barringer, "Meteor Crater in Northern Central Arizona." Private Publ., read Nat. Acad. Sci., Nov. 16, 1909, p. 5.

[7] B. C. Tilghman, "Coon Butte, Arizona," *Acad. Nat. Sci. Phila. Pr.*, Vol. 57 (1905), pp. 887–914.

[8] D. M. Barringer, "Coon Mountain and its Crater," *Acad. Nat. Sci. Phila. Pr.*, Vol. 57 (1905), pp. 861–886.

[9] *Op. cit.*

[10] H. L. Fairchild, "Origin of Meteor Crater (Coon Butte), Arizona," *Bull. Geol. Soc. Am.*, Vol. 18 (1907), pp. 493–504.

[11] *Op. cit.*

pitted. Likewise the tufa domes southwest of Searles Lake in California are but slightly affected by solution, although they are believed to be of late Wisconsin age. On the much older and higher terraces of this lake, which the writer correlates with an earlier (Tahoe) glacial epoch,[12] the tufa domes are even more honeycombed by solution than the limestone blocks at Meteor Crater. These facts alone suggest that the latter may belong to the last interglacial age.

A study of the ravines and small graded valleys on the parapet indicates that the latter has suffered more erosion than the latest (Tioga) glacial moraines, but hardly so much as those of an older epoch. It is also significant that one of the graded dry "washes" which runs out from the parapet into the general surface of the plateau shows no change of form or geomorphic age in passing from the débris mass out over the plateau. This indicates that the entire ravine as seen to-day has developed since the débris cone was built upon the plateau. From this one may conclude that the crater is older than the present sub-cycle of erosion of the plateau surface.

As a fifth source of evidence, the present condition of the talus slopes within the crater affords instructive suggestions regarding the physiographic history. A close scrutiny of the talus shows that it is no longer growing but has been extensively eroded into a series of ravines between which a few wedge-shaped remnants of the talus still remain. The talus is therefore the product of an earlier age, long since past. It is a well-known fact that talus formation is particularly favored by the wedge work of ice ("frost action"), and aridity tends to prevent it. In all our deserts to-day talus slopes are, with local exceptions, wasting away. On the lower slopes of Death Valley only a few small remnants of talus now remain as relics of a previous age when climatic conditions were favorable to its growth. If we suppose the crater to be of Pleistocene age, the moist cold climate of the last glacial epoch would have promoted frost action and talus growth, whereas the arid interglacial and Recent epochs would have suppressed such growth and induced the ripping of the talus by sudden torrents ("cloudbursts"). It is these torrents that are now enlarging the alluvial fans which have crept out over the lake beds.

It seems very significant that the evidence along these five independent lines points to a long period of atmospheric action and also rather definitely to climatic changes from warmer and drier to colder and moister and back to dry again. From these considerations the writer is led to suspect that the crater was made during the last interglacial (or post-Tahoe) epoch, perhaps 40,000 to 75,000 years ago. Of course no finality can be claimed for this estimate, but as a counterbalance for the current view that the crater is only a few thousand years old it has considerable value.

[12] Eliot Blackwelder, "Pleistocene Glaciation in the Sierra Nevada and Basin Ranges," *Bull. Geol. Soc. Am.*, Vol. 42 (1931), pp. 865–922.

SCIENTIFIC EVENTS

REORGANIZATION OF FEDERAL SCIENTIFIC BUREAUS

A REORGANIZATION of the federal executive departments will be effective in February upon executive orders issued under Congressional authority by President Hoover, unless Congress rejects the plans. Science Service summarizes the major changes in the scientific and engineering bureaus of the federal government as follows:

The U. S. Public Health Service, now in the Treasury Department, will be transferred to the Interior Department and made part of the new division of education, health and recreation which will include bureaus with these functions which are largely already in the Interior Department.

A new Division of Public Works is also established in the Department of the Interior in which practically all the non-military engineering activities of the War Department, which include river and harbors, flood control and similar work are incorporated.

The Bureau of Public Roads, now in the Department of Agriculture, is placed in this public works division, thus giving it jurisdiction over the extensive federal aid highway program.

The Treasury's Supervising Architect office is also transferred to the Public Works Division and numerous commissions and offices also dealing with government construction and purchasing are brought together in the same division for more economical administration.

The General Land Office of the Interior Department is given to the Department of Agriculture and grouped with the Forest Service, the Biological Survey and the Bureau of Chemistry and Soils already in the department into a division of land utilization.

The Hydrographic Office of the Navy and the Naval Observatory are incorporated into a new Department of Commerce Merchant Marine Division, and the Hydrographic Office is merged with the Coast and Geodetic Survey. The same subdivision of the Department of Commerce will include the United States Shipping Board Emergency Fleet Corporation.

The Weather Bureau, long in the Department of

Agriculture, is fitted into the Department of Commerce among bureaus that serve commerce and industry. The National Advisory Committee for Aeronautics, which has been an active research independent establishment since world war days, is merged with the Bureau of Standards.

REDUCTIONS IN THE FEDERAL BUDGET FOR SCIENTIFIC WORK

IN the budget estimates submitted to Congress on December 5, by President Hoover, many of the scientific bureaus are given reduced appropriations. The following figures, selected by Science Service, show the individual appropriations affected. These cuts are in addition to those covered by the economy legislation passed at the last session.

The Department of Agriculture shows the following decrease: Office of Experiment Stations, $44,797, which will affect the the work in stations in Hawaii and Puerto Rico; Office of Extension Service, $12,846, involving cutting down agricultural exhibits at fairs; Weather Bureau, $92,568 for weather service and research, $4,200 for horticultural protection, and $107,835 for supplying information regarding weather conditions to aviation; Bureau of Dairy Industry, $19,803, which represents the amount appropriated in 1932–33 for completing a nutrition laboratory at the Beltsville, Maryland, experiment station; Bureau of Plant Industry, $29,185 for cereal crop investigations, $11,905 for forage crops and diseases, $10,462 for sugar plant investigations and $7,950 for western irrigation agriculture; Bureau of Chemistry and Soils, no changes affecting research; Bureau of Entomology, $4,775 for investigations relating to fruit and shade tree insects, $4,400 for forest insects, $10,390 for cereal and forage insects and $5,820 for household and stored-products insects; Bureau of Biological Survey, $4,810 for studies of food habits of birds and animals, and the remainder of the $156,270 decrease for this bureau is planned to be accomplished by delaying purchase of lands and sites for wild bird and wild life refuges.

Bureau of Agricultural Engineering, $28,603 for engineering investigations; Bureau of Agricultural Economics, $11,430 for research concerning marketing and distribution of farm products; Bureau of Home Economics, $4,724 from investigations.

The Bureau of Plant Quarantine, however, is given $39,501 increase so that additional work may be done in preventing the spread of the pink bollworm of cotton, the gipsy and brown tail moths, and the Japanese beetle. Less money is allowed for preventing the spread of the date scale, the thurberia weevil and the European corn borer—the total sum of these last items amounting to $85,015, in decreases.

The Bureau of Standards is untouched this year excepting for an increase of $188,720 to do away with the 1933 administrative furloughs.

The Coast and Geodetic Survey was given an apparent decrease of $1,239,813, but this sum represents the emergency relief appropriations of 1933.

The Bureau of Mines has $26,025 less for investigating mine accidents, and $7,090 less for helium investigations.

The Geological Survey's planned appropriations have been increased by $399,000, made up as follows: Salaries, $15,000; topographic surveys, $184,000; geological surveys, $40,000; fundamental research, $10,000; volcanologic surveys, $5,000; Alaskan mineral resources, $5,000; gaging streams, $70,000; classification of lands, $10,000; printing and binding, $20,000; geologic and topographic maps, $15,000, and mineral leasing, $25,000.

Increases for international agency expenses recommended for the State Department would include, $10,000 for the Gorgas Memorial Laboratory; International Institute of Agriculture at Rome, $5,400, and International Council of Scientific Unions, $5,042. The last two were not appropriated for in 1933.

It is recommended that the Public Health Service should receive a net increase of $173,266, but the principal increases are $220,000 for pay of personnel and maintenance of hospitals and to provide additional facilities in new hospital buildings constructed as a part of the Federal building program and $55,000 for purchase of equipment for new quarantine stations. Reductions in the force which have been made during the year, however, mean $34,984 decrease for pay of acting assistant surgeons and $25,000 has been cut from the estimate for field investigations and $50,000 from studies of rural sanitation.

The Smithsonian Institution is given certain slight increases in the estimates, mostly for supplies, materials, printing and binding.

UNEMPLOYED CHEMISTS IN NEW YORK CITY

THE New York Committee on Unemployment and Relief for Chemists and Chemical Engineers announces that nineteen colleges and universities will cooperate in research projects to be carried on by unemployed chemists. Columbia, Princeton, New York and Rutgers Universities have pledged laboratory space and materials. Similar cooperation will be extended by a number of hospitals in the metropolitan area. Research workers have been placed in the laboratories of Columbia University and the Medical Center with funds provided by the committee. Other researches will be started as soon as they can be financed.

It is estimated that about 2,000 of the 10,000 chem-

ists and chemical engineers who live or work within fifty miles of City Hall have been laid off. About 900 have registered with the committee and registration continues at the rate of from five to twenty per week. A considerable number—between 25 and 50 per cent.—have obtained some form of temporary work. Others are occupying their time in researches, either in laboratories in their homes or in the libraries. Since last January the committee has helped to get permanent or temporary jobs for 184 men and women. Ten to twenty people per week have received relief in the form of work or direct contributions.

It is estimated that for the eight months from November 1 to July 1 between $50,000 and $60,000 is needed to help about 100 men and women and their families. This is at the rate of about $15 a week. It is hoped that of this amount $32,000 can be raised directly from the profession and that the balance of from $18,000 to $28,000 may be contributed by the chemical industry.

The committee's object is to furnish work for idle chemists that will not bring them into competition with regularly employed members of the profession, and at the same time to advance research in pure science.

It will not send out unemployed chemists to compete in industry for jobs at reduced salaries. Men who have been placed in competitive positions have been urged by the committee to ask for their regular salaries, and in no case has an appeal been made to any employer to employ a man at a reduced salary because he is in need.

AWARD OF THE EDISON MEDAL TO BANCROFT GHERARDI

THE Edison Medal for 1932 has been awarded by the American Institute of Electrical Engineers to Bancroft Gherardi, "for his contributions to the art of telephone engineering and the development of electrical communication."

The Edison Medal was founded by associates and friends of Thomas A. Edison, and is awarded annually for "meritorious achievement in electrical science, electrical engineering or the electrical arts" by a committee consisting of twenty-four members of the American Institute of Electrical Engineers. The following eminent engineers and scientific men have been recipients of the medal: Elihu Thomson, Frank J. Sprague, George Westinghouse, William Stanley, Charles F. Brush, Alexander Graham Bell, Nikola Tesla, John J. Carty, Benjamin G. Lamme, W. L. R. Emmet, Michael I. Pupin, Cummings C. Chesney, Robert A. Millikan, John W. Lieb, John White Howell, Harris J. Ryan, William D. Coolidge, Frank B. Jewett, Charles F. Scott, Frank Conrad and Edwin W. Rice, Jr.

Bancroft Gherardi was born in San Francisco on April 6, 1873. Upon the completion of his studies at Cornell University, he entered the employ of the New York Telephone Company under Dr. John J. Carty, who was then chief engineer. From 1900–06 he was chief engineer of the New York and New Jersey Telephone Company; from 1906–07 assistant chief engineer of the New York Telephone Company, and from 1907–18 engineer of plant, American Telephone & Telegraph Company. In 1918 he became acting chief engineer and shortly afterward chief engineer of the company. Since 1920 he has been vice-president and chief engineer of the American Telephone & Telegraph Company.

H. H. Henline, acting national secretary of the American Institute of Electrical Engineers, writes:

> Mr. Gherardi's entire professional and business career has been devoted to the art of communication. Coming into this field when the telephone art was very young (300,000 telephones in 1895) he has played a most important part in the development and perfection of operating practices and in the development of methods, equipment and apparatus, which have brought telephone communication to the high state of perfection in which we find it to-day.
>
> Mr. Gherardi has directed the development and introduction of many new and improved arrangements which are in use to-day on a large scale, and which have added greatly to the speed and accuracy of local and long distance telephone service.
>
> His broad vision as to the place of communication not only in the affairs of the people of the United States but also in world affairs and his initiative and skill in the development of engineering and operating organizations and in the development of the art generally have contributed enormously to the growth and success of present-day communication.

SCIENTIFIC NOTES AND NEWS

DR. WILLIAM SYDNEY THAYER, professor of medicine emeritus at the Johns Hopkins University, died on December 11, at the age of sixty-eight years.

DR. WILLIAM JACOB HOLLAND, director emeritus of the Carnegie Museum, Pittsburgh, died on December 13, at the age of eighty-four years.

THE Paris Academy of Sciences awarded on December 5 the Grand Prix founded by the late Prince Albert of Monaco to Prince Louis de Broglie, a former winner of the Nobel Prize for physics. The prize is valued at about $3,900.

THE Gold Medals "for distinction in science" of the

Society of Arts and Sciences of New York City were presented on December 8 at a dinner given by the society to Dr. William Crocker, director of the Boyce Thompson Institute of Plant Research, and to Dr. Harlow Shapley, director of the Harvard College Observatory. Walter Russell, president of the society, presided, and Dr. H. H. Sheldon, of New York University, presented the medals.

DR. HERMANN PRINZ, professor of pharmacology at the Evans Dental Institute of the University of Pennsylvania, received the gold medal awarded by the Callahan Memorial Commission of Cincinnati, at the annual meeting of the Ohio State Dental Association held in Cleveland on December 5.

IN recognition of his contributions in research and the training of young men for careers in chemistry, the Charles University of Prague has awarded a medal of merit to Dr. Merle Randall, professor of chemistry at the University of California.

ACCORDING to the *Journal* of the American Medical Association, the Charles Mickle Fellowship of the University of Toronto has been awarded to Dr. Gaston Leon Ramon, director of the Pasteur Institute farm at Garches, France, in recognition of his work on diphtheria and practical methods for community protection against infectious disease. The fellowship is awarded each year to the member of the medical profession who is considered by the faculty of medicine of the university to have contributed most to the advancement of medical art or science during the preceding ten years. It is the annual income from an endowment of $25,000 bequeathed to the university by the late Dr. W. J. Mickle.

DR. PEYTON ROUS, member of the Rockefeller Institute for Medical Research, has been elected a corresponding honorary member of the section of comparative medicine of the Royal Society of Medicine, London.

DR. FRIEDRICH RINNÉ, emeritus professor of mineralogy at Leipzig, has been elected an honorary member of the German Mineralogical Society.

DR. LEOPOLD WENGER, professor of Roman and German municipal law at Munich, has been elected president of the Bavarian Academy of Sciences.

MARQUIS GUGLIELMO MARCONI has been elected honorary president of the Comité International Radio-Maritime.

DR. HAROLD BENJAMIN FANTHAM, professor of zoology and comparative anatomy at the University of Witwatersrand, Johannesburg, South Africa, since 1917 and formerly president of the South African Association for the Advancement of Science, has been appointed head of the department of zoology at McGill University, succeeding Dr. Arthur Willey, now professor emeritus.

SIR ALDO CASTELLANI, professor of tropical medicine at the State University of Louisiana and at the Royal University of Rome and lecturer on mycology and mycotic disease at the London School of Hygiene and Tropical Medicine, has been appointed director-in-chief of the Ross Institute for Tropical Diseases, London, to succeed the late Sir Ronald Ross.

DR. E. REEVE HITCHNER has been appointed head of the department of bacteriology at the University of Maine. He succeeds Dr. Fremont L. Russell, who retired last June after forty-three years' service to the university.

DR. LIVINGSTON FARRAND, president of Cornell University, was elected chairman of the board of trustees of the Carnegie Foundation for the Advancement of Teaching at the twenty-seventh annual meeting of the board on November 17. Dr. Farrand succeeds Dr. William Allan Neilson, president of Smith College.

PROFESSOR VICTOR KUHN LA MER, of Columbia University, has been elected chairman of the New York section of the American Chemical Society. He succeeds Dr. Walter S. Landis, vice-president of the American Cyanamid Company. J. M. Weiss, president of Weiss and Downs, Inc., was elected vice-chairman of the section, and Dr. David P. Morgan, Jr., of Scudder, Stevens and Clarke, was named secretary-treasurer. Dr. Landis, Professor D. D. Jackson, of Columbia, Professor Arthur E. Hill, of New York University, and D. H. Killeffer, consulting chemical engineer, were elected to the executive committee.

DR. R. E. ROSE, director of the technical laboratory of E. I. du Pont de Nemours and Company, Inc., was elected president of the American Association of Textile Chemists and Colorists at their annual meeting in Greensboro, North Carolina. The association is actively engaged in the selection of methods for the determination of the fastness of dyed fabrics in conjunction with the Bureau of Standards and the Lowell Textile Institute.

THE directors of the Josiah Macy, Jr., Foundation, of New York City, have made a grant to The Wistar Institute, Philadelphia, in aid of the work on the development of the central nervous system in relation to behavior being done by Dr. George E. Coghill, member of the institute, and Dr. A. W. Angulo, associate.

PROFESSOR PICCARD, who is leaving Brussels on January 4 for the United States, where he will deliver

lectures on the stratosphere, stated to a correspondent of the London *Times* that he had given up all idea of making further ascents. Dr. Cosyns, who accompanied him on the ascent from Zurich, would, he said, make an ascent next summer from a point in Belgium, and would attempt to beat the altitude record. Another ascent, from Hudson Bay, would have the object of studying the deviation of the cosmic rays in the region of the North Magnetic Pole. This ascent would be made in 1934, but Professor Piccard would confine himself to helping in the preparations, and the ascent would have to be made by American physicists accustomed to the Polar climate. The plan was only in the preliminary stage.

DR. DAVIDSON BLACK, of the Peiping Union Medical College, China, gave two lectures on *Sinanthropus* at the University of London on December 9 and 12.

DR. WALDEMAR KAEMPFFERT, science editor of *The New York Times*, addressed the students and faculty of the Carnegie Institute of Technology on December 6, on "Social and Cultural Aspects of Engineering and Invention."

DR. WALTER B. CANNON, of the Harvard Medical School, addressed the second year medical students at the University of Michigan on November 14. His subject was "The Emotional Level."

DR. RAY LYMAN WILBUR, Secretary of the Interior, was the Founders' Day speaker at the Medical College of Virginia, Richmond, on December 1. This was also the occasion for formally opening to the public the new library of the college.

DR. BRONISLAW MALINOWSKI, professor of anthropology at the School of Economics of the University of London, will deliver the Messenger Lectures at Cornell University during the month of March. During April, Dr. Malinowski will visit other institutions with departments of anthropology in order to meet his American colleagues.

DR. PETER DEBYE, professor of physics at Leipzig, who has been lecturing at the Ohio State University and the University of California, will give a series of lectures as Scott professor at the Cavendish Laboratory of the University of Cambridge.

DR. HEBER D. CURTIS, director of the observatory at the University of Michigan, delivered a lecture on the recent total eclipse on December 8 at the Carnegie Institute of Technology under the auspices of the Physical Society of Pittsburgh. Dr. Curtis is a former member of the society.

HENRY GRIER BRYANT, of Philadelphia, the geographer and explorer, died on December 7, at the age of seventy-three years.

GENERAL NICOLA VACCHELLI died on November 19, 1932, at the age of sixty-two years. He was a deputy of the national parliament of Italy, director of the Military Geographic Institute, president of the Italian National Committee for Geodesy and Geophysics, president of the Italian Royal Geographic Society, vice-president of the International Geographic Union and member of the executive committee of the International Geodetic Association.

THE deaths are announced of Dr. Friedrich Wilhelm Fröhlich, professor of physiology at Rostock; of Dr. Peter Stark, professor of botany at Frankfurt, and of Dr. Hugo Bücking, professor of mineralogy at Heidelberg.

THE Baltimore City Medical Society and the Osler Historical Society met recently in joint session. The speakers and their subjects were: Dr. Fielding H. Garrison, "Geomedicine: A Science in Gestation"; Dr. Henry E. Sigerist, "Problems and Methods of Historical Pathology"; Dr. John Ruhräh, "Aztec Methods in Child-Training"; Dr. John Rathbone Oliver, "The Promethean Fantasies of Alexander Scriabin"; Dr. Owsei Temkin, "Views of Epilepsy in the Hippocratic Period," and Dr. William H. Welch, "Vaccination in Maryland."

THE International Congress of Microbiology, which was to have taken place in Berlin in 1933 under the presidency of Professor Hahn, is, owing to existing world conditions, now postponed to 1934.

THE trustees of the Rockefeller Foundation have made a further grant of £5,000 towards the research funds of the British National Institute of Industrial Psychology, to be expended during the years 1933–36.

WE learn from *Museum News* that the Rothschild collection of birds, valued at about $500,000, which the American Museum of Natural History obtained last summer was a gift of the widow and children of the late Harry Payne Whitney. It is the largest single gift the museum has ever added to its collections. The same donors have provided a fund to be used to pay expenses of students of ornithology from abroad.

THE Kellogg Company of Battle Creek, Michigan, recently gave to the board of trustees of the University of Michigan the sum of $20,000 to be used for researches on the effect of caffein, under the direct supervision of Professor Charles W. Edmunds, head of the department of materia medica in the Medical School. The work will be done during the coming period of two years.

SIR HILTON YOUNG, M.P., and Professor Frank Debenham in a letter to the Press call attention to the Scott Polar Research Institute at Cambridge. They

write in part: "After work and hope prolonged for years, a building is about to be provided for the Scott Polar Research Institute at Cambridge, with funds arduously collected over many years. Designs have been prepared by Sir Herbert Baker, R.A., which are admirable as to both space and dignity of appearance. Unfortunately the sum available for building is insufficient to carry out these plans in full, and for lack of another £2,000 we shall have to leave it without its top story for the present. This will not only be a serious handicap to its efficiency but will, of course, make completion more expensive in the long run. Our hope is that some of those who realize the scientific and economic importance of Polar work, besides its appeal to the imagination, will help its future scientific home to start unhandicapped. The gap is not wide. Sir Louis Baron has started to bridge it with £100. Will not others complete the bridge?"

AT a meeting held at Washington University in St. Louis on November 26 a new sub-committee of the National Research Council was organized for the encouragement and guidance of further research on the origin of the sulfide ores of the Mississippi Valley Region, especially those of lead and zinc which constitute the world's most important sources of these metals. New studies in the paragenesis of the ore minerals are already well under way. Critical correlation studies of the ore-bearing horizons in the various producing districts have been initiated under the guidance of Professor R. C. Moore, and the preparation of a large scale map showing the structural features of the region will be undertaken under the supervision of Professor A. W. Giles. Several other lines of investigation have been mapped out and a field meeting of the committee for the study of critical localities is planned for September of the coming year. The present membership of the committee includes: E. S. Bastin (*chairman*), E. F. Bean, C. H. Behre, Jr., G. C. Branner, H. A. Buehler, C. L. Dake, W. H. Emmons, G. M. Fowler, A. W. Giles, M. M. Leighton, W. E. McCourt, E. T. McKnight, H. S. McQueen, R. C. Moore, W. A. Tarr and S. Weidman.

WE learn from *Nature* that a special exhibition dealing with optical phenomena and optical instruments was opened at the Science Museum on November 19. It will remain on view until the middle of February, 1933. A special feature of the exhibition is a number of demonstrations and experiments operable by visitors. These illustrate reflection, refraction, dispersion, interference, diffraction and polarization of light as well as the working of simple optical instruments such as the telescope and microscope. Other demonstrations include a large projection microscope designed for the examination of metals in large pieces, a rangefinder specially adapted to take short ranges in the museum, a home cinematograph projector using standard size film, a large ophthalmoscope for examination of the human eye and a modern epidiascope. The historical development of various optical instruments is illustrated by examples selected from the museum collections, and current practice in optical instrument manufacture will be further represented by a selection of modern instruments lent by various firms especially for the exhibition.

AN area embracing about twelve townships north of Red Lake, Minnesota, became on November 1 an inviolate sanctuary for caribou and other wild life, in accordance with regulations recently prescribed by William T. Cox, Minnesota Commissioner of Conservation. Reports of a herd of caribou in the Red Lake region were confirmed last June by field naturalists of the Bureau of Biological Survey. Dr. Vernon Bailey, in charge of the bureau's investigation, was of the opinion that under the conditions then prevailing the prospects for perpetuating the herd were poor, but making this area a sanctuary is expected to prevent the threatened extermination.

THE report on the work of the British Museum for 1931, as abstracted in the London *Times*, includes an account of the progress of the British Museum (Natural History) at South Kensington, the fiftieth anniversary of which was celebrated on September 29 and 30. The total number of visitors to the Natural History Museum in 1931 was 537,170, as compared with 506,407 in 1930, the present numbers still being below those of the preceding three years. Visitors attending the tours of the official guide-lecturers decreased by 1,935 to a total of 12,533. The advisory and economic activities of the museum included the answering of numerous inquiries relating to mites, ticks and parasitic worms. Advice was also given on the muskrat question, whaling and sealing matters and the corrosion of submarine pipes by Polyzoa and Mollusca. The department of entomology continued to cooperate with the Imperial Institute of Entomology, and in addition 938 economic inquiries were dealt with by correspondence and 561 by interviews. Pests of grain, cereal products and fruit and insects affecting tobacco received much attention. The timber of Gray's Inn Hall and of the Great Hall of University College received detailed examination. In the department of botany a large number of queries on plant diseases, destruction of stored products, human fungal diseases and water pollution were dealt with.

A STATEMENT issued by the Department of Commerce reports that the arc of first-order triangulation extending along the eastern coast of Lake Michigan,

on which work was started early in June, has been completed. The arc passes through Benton Harbor, South Haven, Holland, Grand Rapids, Muskegon, Hart, Ludington, Manistee and Traverse City. This work constitutes a link in the Federal Government's project of triangulation authorized by Congress. Already more than 30,000 miles of arcs or chains of triangles have been extended over the country to furnish starting points for surveys connected with topographic mapping, location of state and county boundaries, surveys in cities and even for the location of monuments on private property. Each triangulation station on this Michigan arc was marked in a permanent manner with a block of concrete into which was set an inscribed metal tablet. A second monument was placed at a distance of about 400 yards from each station to serve as an azimuth mark for local engineers, the true bearing, or azimuth, of this mark being determined by observations during the field work.

DISCUSSION

ST. CROIX'S RAINIEST YEAR CAUSES AN EPIDEMIC OF MALARIA

THE year 1931 will stand out prominently in St. Croix's history. During this time a maximum annual rainfall over a period of 80 years occurred, and the island suffered one of the worst outbreaks of malaria it has ever experienced. Curiously enough, these two phenomena were closely related.

St. Croix, like the other United States Virgin Islands, of which it forms a part, lacks sufficient elevation to provide an important barrier across the path of the northeast trades; and without mountains to elevate these winds and produce rain, the precipitation is undependable. The convectional rain, which reaches a maximum at the time of the high sun, is uncertain in occurrence. The hurricane control, a major influence of the rainiest period, is likewise exceedingly variable. Hence, it is small wonder that annual rainfall, which averages 45.54 inches (80 years), has ranged from a low of 29.48 inches in 1873, 16.06 inches below normal, to a high of 69.81 inches in 1931, 24.27 inches above normal.[1]

An abundance of moisture, producing ideal breeding grounds for millions of mosquitoes, is one of three most basic factors involved in malarial areas of the tropics. The other two are the presence of the anopheles mosquito and persons suffering from malarial fever.

The first factor is vital, for all anopheles are harmless during the greater period of their lives. For instance, out of each 100 anopheles mosquitoes, only a few will have a chance to bite a human being during the period in which his blood contains malarial parasites in the infective stage. Of those which do bite such a person, only a limited number will live the twelve days necessary for the plasmodium to attain its full development in the insect, and of those in which the twelve-day cycle is completed, some may die before they have an opportunity to attack a susceptible person.[2] Thus, it is seen that as regards the epidemic spread of the disease there are interrelated critical points in the amount of rainfall necessary to provide favorable breeding places for the mosquitoes, the number of mosquitoes which are produced, the number of these insects susceptible to infection with the parasite, and the number of human carriers of that parasite. All factors must rise above those critical points if there is to be an epidemic.

From 1918 to 1930 only fifteen cases of malaria were reported in St. Croix, and with one exception, all were confined to persons who had acquired the infection in Puerto Rico. Yet during this thirteen year period it was known by actual tests that anopheles mosquitoes were in the island.[3] The rainfall was not sufficient, however, to furnish them breeding places for rapid multiplication.

The year 1931 gave the proper weather conditions. The malaria epidemic started in July in the most swampy part of Christiansted, the district of Gallows Bay. Before it was checked it spread through the island. A final count showed over 900 cases received medical aid and 22 deaths were the result of its ravages.[3] Probably many additional fatalities were induced by its weakening influence, the victims being left more susceptible to some other serious disease. Moreover, losses from sickness and death were not the only unfavorable results. There was an economic loss to laborer and employer in the number of days the workers were absent and in the lowering of the efficiency after their return. Again, St. Croix has been attempting to build up a much-needed tourist industry to supplement its declining sugar production. Word of the epidemic reached national dailies in the eastern United States, and passengers from

[1] Rainfall statistics are an average for three major stations, Christiansted, Kings Hill and Fredericksted. Data were furnished by the U. S. Weather Bureau, Washington, D. C., and the Agricultural Experiment Station at Christiansted.

[2] Weston P. Chamberlain, "Twenty-Five Years of American Medical Activity on the Isthmus of Panama," p. 12, The Panama Canal Press, Mount Hope, C. Z., 1929.

[3] This information was obtained from Dr. J. I. Knott, government physician at Christiansted, St. Croix.

more than one boat refused to stop at the island for fear of incurring infection.

St. Croix's uncertain rainfall régime will bring heavy precipitation years again. This in turn will increase the malaria hazard. Yet by exercising extreme care through draining her low-lying areas and by inaugurating other preventive measures so successful in the Canal Zone, the island can minimize possibilities of another serious outbreak.

EARL B. SHAW

DEPARTMENT OF GEOLOGY,
SMITH COLLEGE

LIMESTONE CAVERNS

AN interesting confirmation of some of the points set forth by W. M. Davis in his paper on "The Origin of Limestone Caverns" was found in the course of field work in southern Kentucky. Davis elaborates the principle that caverns are opened by solution below the ground water table and later are exposed and subjected to corrasion by the lowering of the ground water. The discovery of a cavern opening below the lowest level of the Cumberland River seems to give evidence at least of the possibility of active solution below the water table.

The cavern in question is located on the recently published Burnside Quadrangle of the U. S. Geological Survey. It lies about a mile southeast of Sloans Valley station in the northeast part of the map. This is a part of the Cumberland Plateau, near the western margin. Sandstone and conglomerate strata overlie a series of limestone formations of various degrees of solubility. In this part of the plateau the streams have uncovered the top of the limestone strata in the valley bottoms, and typical karst forms have been developed—dolines and ponors leading to caverns, underground drainage, etc. The Cumberland River flows through marked intrenched meanders, still youthful, and incised below an erosion level probably continuous with the level of the Highland Rim country immediately to the west. Low water in the present river, therefore, represents the lowest level to which the ground water table in this area has fallen, at least in the later chapters of the local physiographic history. Cavern openings below the lowest water level, such as may be observed on the southwest bank of the Cumberland River on Haynes Bend, confirm the principle that these openings may have been produced below the water table.

PRESTON E. JAMES

UNIVERSITY OF MICHIGAN

EFFECT OF AN IODIDE FERTILIZER ON IODINE CONTENT OF A FOOD PLANT

OWING to the possible therapeutic value of iodine-containing foods, some interest attaches to a preliminary experiment on the effect of an iodide applied to the soil on the iodine content of turnips. White egg turnips were grown under uniform conditions, except that one half the plots received potassium iodide at the rate of two kilograms per hectare, while the other plots received a chemically equivalent amount of potassium chloride. The potassium salts were applied in the row. The yield of roots and tops was slightly, but not significantly higher with the chloride than with the iodide. However, the small amount of iodide added produced significant differences in the iodine content of the turnips. The iodide-treated plants contained 441 and 950 parts per billion of iodine in the roots and tops, respectively, against 165 and 441 parts in the chloride-treated plots. Whether these quantities of iodine in food have therapeutic value is not known to the writers, but the experiment indicates the possibility of large relative increases in iodine content of root crops by the application of iodides.

A. B. BEAUMONT

MASSACHUSETTS AGRICULTURAL
EXPERIMENT STATION

GEO M. KARNS

MELLON INSTITUTE OF INDUSTRIAL
RESEARCH

THE THOMAS SAY FOUNDATION GETS UNDER WAY

THE idea behind this unique and penniless foundation is that by the sale of technical monographs on insects to members of the Entomological Society of America (and to others) money will be obtained for publishing additional books, and the list will grow and be cumulative. It has begun to grow. The first volume issued was a monograph of the Dipterous genus Sacrophaga, by J. M. Aldrich; the second, a monograph of the Stoneflies (order Plecoptera) of North America, by Needham and Claassen; and third, recently issued, a monograph of Stonefly Nymphs, by P. W. Claassen (C. C. Thomas, publisher). With the issuance of this volume the series is well under way.

Stoneflies have no great beauty that collectors should desire them, and they have little economic importance. Hence their study has been greatly neglected. Volume two of this series, treating of adults, and this third volume treating of the immature stages, together constitute the first gathering up of knowledge of our fauna in this most primitive order of winged insects. Both are pioneer descriptive treatises, indispensable for further work upon our Plecopterous fauna. Five families are now recognized in our fauna, one of them, Peltoperlidae, being new.

Contrary to the statements current in some repu-

table entomological text-books, the nymphs of four of these five families are shown to be herbivorous in their feeding habits, and those of only one (Perlidae) are carnivorous. All are lotic, living in moving water, either in streams or on wave-washed shores.

The illustrations in this third volume are particularly fine. These represent all the families and all but three of the genera of our fauna. It satisfactorily fills a big gap in the knowledge of our North American insects.

J. G. NEEDHAM

CORNELL UNIVERSITY

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

BIOLOGICAL SCIENCES AT ATLANTIC CITY

THE American Society of Zoologists, in cooperation with Section F of the association, will present a program similar in general plan to the programs of previous years. On Wednesday morning two sessions will be held simultaneously, one on physiology and the other on embryology. The physiology program will include papers on growth in relation to temperature and other factors, on the swimming activity of spermatozoa, on germ cell development as affected by aspirin and on the newly discovered third hormone of the anterior pituitary. This hormone has been named "prolactin" by Dr. Oscar Riddle, of the Carnegie Institution at Cold Spring Harbor, and has been identified with milk secretion. On the embryology program are papers on the tissue culture of rabbit embryos, on the rôle of cytoplasm and chromosomes in the early development of salamanders and on the growth of nerve cells from the rat transplanted to the allantois of the chick. A method for studying developmental factors by x-ray radiation will be described.

Wednesday afternoon will be devoted to sixteen demonstrations in various fields of zoology. Especially interesting to scientific men in general will be moving pictures of a developing sea-urchin egg by Robert Chambers, of New York University; a new glass electrode for measuring pH of minute amounts of body fluids by I. R. Taylor, of Brown University, and newly designed apparatus for determining the temperature, salinity, biological population and rate of flow simultaneously of sea water at different depths, by T. C. Nelson, of Rutgers University. At 4:30 P. M. on Wednesday, Carl C. Speidel, who was awarded the general A. A. A. S. prize in 1931, will give a lecture on the growth of living nerves, illustrated by thirty minutes of motion pictures.

Thursday morning three simultaneous sessions will be held dealing with physiology, cytology and ecology. Papers on the sexual hormones, on regeneration and transplantation of various kinds of tissues and on the depression of bioluminescence by narcotics are important on the physiology program. Among the cytological papers four are on the chromosomes of as many different animals, one on the reactions of marine blood corpuscles to vital dyes, and another on the remarkable mathematical precision with which epithelial cells arrange themselves into definite patterns. Four papers on ecology will be presented at the joint session with the Ecological Society of America. On Thursday afternoon the final sessions for reading of papers will be held. In the physiological section there will be a group of papers dealing with such varied subjects, as the use of the precipitin reaction in studying evolution, the rôle of neurohumoral secretions and other endocrines in controlling color changes, the responses of caterpillars to sounds illustrated by motion pictures, the sensitivity of animal eyes to different regions in the spectrum, the functioning of kidney tubules in tissue culture and the effects of x-rays and ultra-violet light on an insect and a protozoan. In the other session a few papers each in the fields of protozoology, parasitology and anatomy will be presented covering histological studies on protozoa, on the human mouth mucous membrane and on the blood of the duck, as well as on germ cell cycles in a salamander, reproduction of a Mexican killifish, a new mutation in Drosophila and life histories of two kinds of female rotifers. In the evening at the Zoologists' dinner Charles Zeleny, of the University of Illinois, will give the vice-presidential address of Section F on "Genetics and Embryology."

Friday morning will be given over to a symposium on "Embryonic Determination," at which papers by E. G. Conklin, Princeton University; D. H. Tennent, Bryn Mawr College; R. G. Harrison, Yale University; B. H. Willier, Chicago University, and Paul Weiss, of Germany, will be presented. A discussion is planned at the end of each paper. In the afternoon there will be held the usual joint symposium with the American Society of Naturalists, the Botanical Society of America and the Genetics Society of America.

On Saturday a field trip to visit the oyster industry of New Jersey will be led by T. C. Nelson, of Rutgers University, who is in charge of oyster investigation for the state of New Jersey.

The Entomological Society of America will hold sessions on Wednesday and Thursday. One session will be devoted to a symposium on "The Influence of Civilization on the Insect Fauna of North America."

The American Association of Economic Entomologists will hold sessions from Wednesday morning, December 28, to Saturday morning, December 31. Topics to be considered will include plant quarantine and inspection, agriculture, extension entomology and insect toxicology.

A short description of some phases of the program of the American Society of Parasitologists appeared in SCIENCE for November 25.

At a joint session of Section G with the associated botanical societies, Dr. E. D. Merrill, retiring vice-president for Section G, will discuss the interrelations between crops and civilizations. This session will also include a memorial program celebrating the centenary of Julius von Sachs (1832–1897). Sachs will be characterized by one of the speakers as the last of the epitomists; another address will deal with Sachs as the man and the teacher; a third will stress the influence of the Sachs text-book on botany in America.

The physiological programs will include a wide range of topics, of considerable interest and importance. Papers will deal with photosynthesis of normal leaves and of those treated with ether and chloroform; the effects of illuminating gas on oak trees and other plants; the influence of carbon monoxide in stimulating root production; effects of carbon dioxide storage on fruits and vegetables; soil aeration and plant metabolism; nitrogen fixation by Myxophyceae; hydrogen-ion concentration of plant sap, and the influence of hydrogen-ion concentration on oxidase activity and on plant distribution; toxicity of normal and pathological blood for seedlings; mechanism of dormancy in seeds and changes occurring during after-ripening; neophyosis, or rejuvenescence of nucellar bud seedlings in Citrus.

Papers on general botany will deal with many subjects, of which the following may be mentioned: thermal distribution of the Myxophyceae of the Yellowstone National Park; comparative resistance of a plant virus and of bacteria to monochromatic light; ontogeny of phloem in healthy sugar-beets and in those affected with curly-top; pathological anatomy of roots attacked by nematodes; responses of tobacco to topping; embryogeny of plants; differentiation of mesophyll tissue; flower variation; life history of *Coenogonium linkii;* symmetry and bending in Marsilea and Pilularia; polyploidy in Alliums; somatic chiasmotypy, and meiosis in Digitalis.

Systematic botany will be well represented with a symposium on objectives and methods in field work, including papers on the significance of compilers' data, objectives of plant exploration work of the U. S. Department of Agriculture, etc. One session will be devoted principally to recent progress in American agrostology, with papers on grasses of Yucatan, eastern Asia and eastern North America. An interesting field trip is planned to the pine barrens and coastal marshes of New Jersey.

Ecological phases of botany will be treated in a series of important papers, including the following topics: Heterogeneity of natural vegetation as an indicator of soil heterogeneity; new black porous-porcelain spheres for estimating the drying influence of sunshine; spherical *versus* horizontal plane surfaces for the atmometric integration of solar radiation; ecology of Alaskan forests; pollen analysis of a Kodiak bog, and epharmony in a New Zealand Rubus.

The American Phytopathological Society plans joint sessions as follows: (1) With Section G and Associated Societies, on Wednesday afternoon, (2) With the Mycological Society, on Thursday afternoon. In addition to the usual general program it is planned to arrange a series of discussion sections in which papers selected on the basis of a theme of common interest will be grouped. Business sessions will follow papers scheduled for Wednesday and Friday mornings. The annual dinner of the society will be held on Wednesday evening in the Madison Hotel.

The Genetics Society of America plans a joint session with the American Society of Naturalists, the American Society of Zoologists and the Botanical Society of America for a symposium on Friday afternoon. Tuesday morning will be devoted to a symposium on applied genetics, dealing with the evaluation of breeding individuals by means of progeny tests. Regular sessions for the reading of short papers will occupy the remaining forenoons. The afternoons will be kept free for informal discussion, demonstrations and exhibits. Wednesday noon there will be a Genetics Society luncheon followed by a business meeting.

Other societies related to the botanical or zoological sections or to both that will hold sessions in Atlantic City are the American Society of Plant Physiologists, the Phi Sigma Biological Society and the American Nature Study Society.

Section O of the association has arranged a joint session with the American Society of Agronomy for Wednesday, December 28, both morning and afternoon. The program will consist of invitation papers on the general symposium subject, "Nitrogen in Relation to Crop Growth and the Use of Nitrogen Fertilizers." Among the speakers will be Director J. G. Lipman, of New Jersey; Director B. E. Gilbert, of Rhode Island; Dr. A. B. Beaumont, of Massachusetts; Dr. S. A. Waksman, of New Jersey; Professor J. W. White, of Pennsylvania; Professor A. W. Blair, of New Jersey; Professor G. L. Schuster, of Delaware; Dr. R. P. Thomas, of Maryland, and others who have been invited to appear on the program. The address of the retiring chairman of Section O, Director C. G.

Williams, of the Ohio Agricultural Experiment Station, will be given at the joint dinner with the American Society of Agronomy on the evening of December 28 at the headquarters hotel.

The American Society for Horticultural Science will hold its meetings on December 28, 29 and 30. There will be sessions devoted to genetics and fruit breeding, small fruits, grapes, propagation of plants, tree fruits, growth and nutrition, vegetable crops, floriculture, ornamentals and economics. There will be a joint session with the American Society of Plant Physiologists on Thursday forenoon. The retiring president, Dr. H. A. Jones, of the University of California, will give an address at the annual banquet to be held Thursday evening. On Friday there will be a joint session with the section on agriculture, which will be addressed by Dr. C. G. Williams, director of the Ohio Experiment Station.

REGISTRATION AND RAILWAY RATES

GENERAL registration for the Atlantic City meeting of the American Association for the Advancement of Science and Associated Societies will be held in the ballroom of the Municipal Auditorium, which is centrally located on the boardwalk. This office will be open from Tuesday morning, December 27 at 9:00 o'clock to 12:00 o'clock Saturday noon, December 31. The registration fee for the Atlantic City meeting is $1.00. Every one interested in the advancement of science who expects to attend any of the meetings is urged to register.

General programs will be available at the registration offices from Tuesday morning to Saturday noon. Each registrant will be supplied with a free copy of the general program which will be a book of 300–400 pages. Non-registrants may purchase programs for $1.00 each.

Reduced railway rates by the standard certificate plan have been granted by almost all railroads in the United States and Canada. Persons attending the meeting should purchase a first-class, full-fare, one-way through ticket to Atlantic City, securing a certificate on the "Standard Certificate Form" reading "for the Atlantic City meeting of the American Association for the Advancement of Science and Associated Societies." Persons should leave their railway certificates at the validation desk to be called for later at the same place. Each person presenting an endorsed and validated certificate may purchase a continuous passage, one-way, return ticket for one half of the regular fare, by the same route as that followed on the trip to Atlantic City. The earliest dates at which tickets may be purchased range from December 20 for the most distant territory to December 23 for the nearest places. Certificates may be validated from December 27 to December 30. The last date on which return tickets may be purchased is January 4, 1933. There is a possibility that some of the railroads will offer excursion rates lower than the rates on the certificate plan. Members are urged, therefore, to consult their passenger agents before purchasing tickets.

CHARLES F. ROOS,
Permanent Secretary

THE NATIONAL ACADEMY OF SCIENCES

PAPERS PRESENTED AT THE ANN ARBOR MEETING. III

(*Continued from page 547*)

Diurnal variation in efficiency: NATHANIEL KLEITMAN (introduced by A. J. Carlson). Our diurnal sleep habit manifests itself in a certain degree of drowsiness which overtakes us every evening and gradually reaches an intensity that makes resistance to the onset of sleep well-nigh futile. Is this inclination toward sleep at the end of a day's activities dependent upon or independent of other periodic changes showing a 24-hour cycle? To answer this question a number of adult subjects were subjected to several simple tests at different times of the day, and variations in performance noted as regards the length of time required to carry out a certain task, or the number of errors made in a definite period of time, or both. The tests were made five times daily, for at least 20 days: A—immediately upon getting up in the morning; B—one hour later; C—just before lunch; D—just before supper; E—just before going to bed. The tasks chosen were such that they could be performed by the subject without outside help, and in the privacy of his own home. They were: *1*—copying a text; *2*—transcribing a text into code; *3*—sorting cards; *4*—dealing cards; *5*—multiplication of large numbers; *6*—mirror drawing; *7*—the ability to keep a stylus in a small hole without touching the edges; *8*—the ability to stand upright without swaying. The results obtained indicate a well-marked variation in performance during the day, efficiency of performance (reciprocal of time or errors), increasing up to noon or afternoon, then declining for the rest of the waking period. The body temperature varies in the same sense. There are indications that the temperature is dependent upon the tonus of the skeletal muscles, in that it falls upon lying down and rises upon getting up. If the variations in temperature can be used as a criterion of changes in tonicity of the body musculature, it would appear that the gradual decrease in efficiency toward the end of the day might be due to greater muscular relaxation, which leads to a decrease in the number of proprioceptive impulses reaching the cerebral cortex and makes it increasingly difficult to maintain the state of wakefulness, irrespective of

whether or not any fatiguing work was done during the day. It is hardest to keep awake during the early hours of the morning when the body temperature is lowest. Under ordinary conditions, going to bed in the evening results in a still greater muscular relaxation, and sleep is precipitated.

A metabolic change in surviving nerve and other tissues: RALPH W. GERARD (introduced by A. J. Carlson).

The in vitro respiration of nerve: T. H. CHANG, R. W. GERARD and M. SHAFFER (introduced by A. J. Carlson). We have previously reported that nerves kept in a medium containing a low calcium ion content show an increased respiration, similar to their heightened irritability. Even in the presence of adequate calcium, however, as in unbuffered Ringer solution, dog nerves (also brain, liver, kidney, muscle) at 37° show a marked rise in oxygen consumption after 6 to 7 hours (sooner in NaCl); whereas when suspended in dog serum such a late rise does not appear, at least for 20 hours. Further, at the start and until the rise begins, the absolute oxygen consumption in serum is greater than in Ringer (35 per cent. for dog vagus: $Qo_2 = 174$ in Ringer, 237 in serum), due to other factors than calcium. Serum was handled in various ways in an attempt to identify the factors increasing the original respiratory rate and preventing the late increase in oxygen usage. Despite results that spoke against a bacterial causation of the late rise, experiments under aseptic conditions finally proved bacteria to be responsible for it, the serum preventing their growth by moderately heat-labile bacteristatic substances in the protein fraction. The initially high values in serum seem to be related in part to a similar fraction. Some of the facts established during the study are appended, and it may be noted that such respiration studies afford an admirable means of studying the antibacterial action of blood, as well as contributing information about the effect of blood constituents on tissue respiration. The two effects of serum are not altered by preservation for 5 days at 5° C. Heating for 15 minutes at 80°, probably 2 hours (not half an hour) at 60° destroys the preserving action of serum, but does not lessen its ability to increase the initial respiratory rate of nerve. Serum diluted with Ringer acts in proportion to its dilution in both respects. A protein-free ultrafiltrate of serum is not bacteristatic, nor does it increase nerve respiration to any extent above the value in Ringer. Cerebrospinal fluid behaves like the ultrafiltrate. Egg white acts much like whole serum in preventing bacterial growth and increasing nerve respiration, as does also serum after repeated ether extraction. The above evidence suggests the importance of proteins, but their action may depend on colloidal as well as chemical factors. Thus, gum arabic added to Ringer also delays considerably the bacterial rise in oxygen usage but lowers the initial rate. Nerves kept in Ringer, even if hypertonic, gain in weight over several hours, in some cases more than a third the initial weight, whereas in serum the gain is small (or absent). Heated serum (80°) again behaves like Ringer. Crude lecithin suspensions prevent the late rise and greatly depress the initial respiration, by half to three fourths. Choline-free lecithin has little effect on the bacterial action, but decreases the initial respiration, less than does lecithin itself; and acetyl choline greatly and progressively lowers nerve respiration to near cessation and prevents the bacterial rise. Of serum extractives, urea has no effect, but the amino acid, glycine, added to Ringer or serum may give a 20 per cent. increase in initial respiration, without affecting the late rise. Lactic acid (contrary to the case of frog nerves at 20°) increases respiration; glucose does not. One third of the creatine-phosphate of frog nerve kept in Ringer at 37° breaks down in three hours, one half in nine hours. A nerve killed by boiling or grinding is attacked by bacteria much faster than one not so treated; so that the slower change in Ringer than in saline (possibly also for serum) may still document a better preservation of the tissue.

Observations on the nervous control of respiratory movements: ROBERT GESELL and C. MOYER (introduced by F. G. Novy).

Methods of synthesizing pure-breeding types with predicted characters in the jimson weed: ALBERT F. BLAKESLEE and A. DOROTHY BERGNER. Plant and animal breeders in the past have had little real control of the production of new types. By means of radiation treatment they have recently been able greatly to increase the rate of mutation without, however, controlling the kind of mutants produced. In the jimson weed (*Datura stramonium*) gross changes in the chromosomes as well as mutations in the individual genes have been abundant after radiation treatment. Segmental interchange may form new kinds of chromosomes made up of parts from normal chromosomes. A chromosome also may be broken in two and one part attached to another chromosome with the remaining part left as a free fragment. From a knowledge of the effects of the factors in the different parts into which the chromosomes have broken, it has been possible to build up pure-breeding types with predicted characters. The essential part of the procedure is the introduction of extra chromosomal material, responsible for the somatic characters desired. Only when this extra material is capable of being transmitted by the pollen as well as by the egg cells can a true-breeding type be secured. Three examples are given of such synthesized types secured by use of parts of the large 1 · 2 chromosome. The ·2 half of this chromosome can be transmitted by the pollen, but the ·1 half can not. The first type is one in which the ·2 half was translocated to the end of the 11 · 12 chromosome, forming a large chromosome which may be written 2 · 11 · 12 and leaving a free ·1 fragment. When the ·1 fragment is eliminated and the plant made homozygous for the 2 · 11 · 12 chromosome, it has two extra doses of the · 2 half and in consequence shows definite peculiarities in appearance, among which the sugar-loaf-shaped fruits are most conspicuous. A second type was formed by

combining the ·1 fragment with the double half chromosome 2·2 and eliminating entirely the normal 1·2 chromosomes. When homozygous for both the ·1 and 2·2 chromosomes the plant has two extra doses of the ·2 half and takes on the characteristic appearance due to the extra chromosomal material. The third type with two extra doses of the ·2 half was secured by rendering a plant homozygous for the following chromosomes;—2·14, 13·23, and the ·24 fragment and eliminating the normal 13·14 and 23·24 chromosomes. The first type has 24 chromosomes, the other two have 26 and thus differ from normals in chromosome number. These three types are indistinguishable in gross appearance from each other, but are strikingly different from the normal jimson weed from which they have been made up to order, as it were, with definite plan and purpose. They perhaps merit the term of synthesized new "species," since they satisfy the criterion of breeding true and are more different from the normal type than some of the species which already have been described in the genus Datura.

The lipids and proteins of the colon bacillus. A study in bacterial synthesis: H. C. ECKSTEIN and MALCOLM H. SOULE (introduced by F. G. Novy). *B. coli* (Jordan) was cultured on synthetic media under aerobic as well as strict anaerobic conditions. The media were fat free, contained glucose and either cystine or alanine as the only source of nitrogen. The chemical nature of the proteins and lipids was determined. The lipids synthesized were characterized by their small content of unsatured fatty acids and rather large content of the phospholipids. The proteins contained tyrosine, tryptophane, arginine, histidine and lysine, regardless of the type of media or gaseous environment. Cystine was not synthesized.

Further studies on the feather germ reaction as a test for thyroid hormone: BRODA O. BARNES (introduced by A. J. Carlson). Juhn and Barnes[1] described a new indicator for thyroid preparations which involved subcutaneous injection of a small amount of thyroxine or thyroglobulin into a brown leghorn capon. The result was a deposition of black pigment in the feather germ of young feathers, which left a permanent record of the injection. It has been found that this indicator will differentiate between active and inactive iodine in the thyroid gland. Considerable variation occurs in the width of the pigmented area using the same dose in different birds. The minimal dose necessary for a positive response lies between 0.3 and 0.4 mgs. of thyroxine.

Biological significance of protective mechanisms inherent in the myocardium: CARL V. WELLER (introduced by F. G. Novy). The myocardium exhibits certain protective mechanisms which are seemingly inherent, and which are not possessed in the same measure by many other tissues of the human body. One of the most obvious of these is dependent upon the pattern of the arterial supply, resulting in an admixture of living and dead tissues, rather than a continuous area of necrosis, following the lesser occlusive lesions. Less easily explained is the comparative freedom of the myocardium from hematogenous metastases of malignant tumors. Similarly, in visceral syphilis there may be an extremely active aortitis, with spirochetes present in large numbers, yet the myocardium may show little or no change. Perhaps the most striking example of all is found in the inability of young trichinae to encyst in heart muscle, although a defensive myocarditis is produced by them. From such diverse examples one must conclude that these protective mechanisms are of biological significance and that they have been developed and perpetuated in order to maintain, in so far as possible, the integrity of the myocardium, so essential for the preservation of the organism.

Higher processes in the behavior of rats: JOHN F. SHEPARD (introduced by W. B. Pillsbury).

Notes on the eclipse table in the Dresden Codex (Maya hieroglyphic manuscript): CARL E. GUTHE (introduced by W. B. Pillsbury). On pages 51 to 58 of the Dresden Codex there exists a chronological table covering a period of 11,960 days or 405 synodic lunar months. The individual members of the table are six-month intervals regularly interrupted by a five-month interval. The table consists of three almost identical equal parts of 135 months each. The arrangement of this record clearly indicates that the Maya were acquainted with the periodicity of eclipses. The efforts of many students have disclosed a series of interesting relationships between this table and other Maya chronological units as well as periodical astronomical phenomena. Several unsuccessful attempts have been made to fit this table into a particular group of data in the hope of establishing a day-for-day correlation between the Maya and the European chronologies. Through an examination of the data on both solar and lunar eclipses visible in the Maya area, considered in terms of whole days (the Maya chronological unit), it becomes evident that this table is a compendium of information upon both solar and lunar eclipses in terms of synodic lunar months and that it could have been constructed from data secured by observation over a relatively short period of time.

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A DELTA METHOD FOR STUDYING MICROSCOPIC SEDIMENTS

FOR twenty years I have had a practical interest in microscopic sediments because they have interfered more or less seriously with my examination of plankton catches in a Sedgwick-Rafter counting chamber. In the last few years I have given considerable attention to papers discussing them in the hope that I

[1] Juhn and Barnes, *Amer. Jour. Physiol.*, 98: 463, 1931.

might get some light on the peculiar features of flotation and settling phenomena of plankton diatoms in sea water.

While my survey of the literature of sedimentation has not been comprehensive, it has been fairly representative, and I have been surprised that no mention has been made of the use of delta formation in the study of microscopic sediments. It has been many years since I first noticed the formation of deltas deposited in the process of filling Sedgwick-Rafter chambers, and it seems to me that any one caring to experiment a little could get excellent results by studying microscopic sediments through use of the delta principle.

I have been too closely occupied with my own routine to give much attention to the possibilities of the method, but I have tried it out a little with a sediment consisting mostly of particles which sank at high speed. With this material injected into a jar of water from a pipette bent to throw the particles directly horizontal at a height of about one inch from the bottom of the jar, I got a delta formation which seemed to have the particles sorted out to about the extent commonly seen in case of the larger particles composing an alluvial fan at the bottom of a moderate slope.

I believe that a little experience would enable one to regulate the height of the jet of sediment above the bottom, the distance from the sides of the vessel, the speed of flow from the jet and the volume of the jet so that the components of a mixed sediment would be fairly well separated in the delta. It appears also that the position of a particular type of particles in a delta formed under known conditions of distances, viscosity of fluid and speed and volume of the jet might provide an index to their rate of settling, as compared with other particles for which the rate may have been determined.

In addition it seems probable that by use of a beam of light thrown to particular or different points in front of the jet in a tall vessel the spread of particles from the jet and their processes of sinking might be followed and a more accurate understanding of their sinking behavior obtained than seems to be available at present. By using fluids of different viscosities for comparison, it might be possible, perhaps, to reach results of fairly high accuracy in this way.

W. E. ALLEN

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A NEW USE FOR CELLOPHANE

IT is sometimes convenient to make records of a permanent nature which can be reproduced on a screen by an arc lamp projection lantern. This can be accomplished in a very simple way at very low cost. Briefly, it is a method of typing on cellophane.

Cellophane is placed upon the carbon side of a sheet of carbon paper, which is placed in a typewriter with a backsheet to protect the rubber roll. Next the typewriter ribbon is adjusted the same as in the making of stencils. The letters which are produced in this way are dark and sharply defined. If a permanent record is to be made, the cellophane is placed between two pieces of glass cut to the size of projection lantern plates. If some discarded lantern plates are available, place them in water for a short time and then the emulsion can be scraped off. The pieces of glass are then sealed around the edges with mending tape. If the record is not of a permanent nature, the cellophane can be used between the plates without the necessity of the plates being sealed.

In making a graph the procedure is the same, with the exception that the graph is drawn on the cellophane with a pencil. The pencil will not mark, but a clear record is obtained from the carbon paper.

Care should be exercised in handling the cellophane, as the completed work can be rubbed off with the hands.

This method has proven satisfactory in the reproduction of the words of songs for chapel exercises and in the making of blueprints and in the drawing of graphs and diagrams to be used during an illustrated lecture when it is impossible to have the use of a blackboard or when a blackboard is not available. These are a few of the uses to which this work is adapted.

KENNETH LYLE WARREN.

DEPARTMENT OF PHYSICS
BATTLE CREEK COLLEGE

A NEW MEDIUM FOR BAS-RELIEF MOLDS

DURING the past spring the science department of the Fountain Valley School of Colorado carried on a series of experiments at Chichen Itza, Yucatan, through the courtesy of Dr. Sylvanus G. Morley, of the Carnegie Institution. These were to determine a technique for rapidly making accurate and durable paper casts of the Mayan bas-reliefs in stone. The material selected for trial was a stereotype wet mat, known as "Nu Tex D," supplied through the courtesy of the Burgess Cellulose Company, of Freeport, Illinois.

After the usual run of failures and half-successes a successful technique was developed. The mats were soaked in water at 85° F—the temperature of the available supply—for several hours. They were then split so that the treated surface of the mat was backed

by only three or four sheets of paper. The surfaced face was then placed against the stone to be cast, which had previously been thoroughly wet with water, and beaten in with a stereotyper's brush. In the case of vertical surfaces it was found necessary to rub some of the stripped backing into a maché and use daubs of it to hold the upper surface in place until the paper was beaten into the engraving. There was found to be sufficient give to the paper to beat into half-inch recesses without tearing. In cases where tearing occurred, as in deep relief or half-inch relief with close vertical sides, the tears were patched by applying small pieces of the stripped back sheets. When this first surface was complete, the deep recesses were filled with a pulp made by rubbing up the stripped back sheets. The excess moisture was then pressed out with the fingers and a sheet of backing patted on as an outer surface. A piece of wet bagging was then laid over the cast and the impression allowed to dry in place. At the time of year we were working, this took between three and six hours, depending upon the time of day and the depth of the relief. When dry the impressions were removed.

In the case of deep relief, it was found wise to finger the first surface to be sure it was in perfect contact with the stone at all points before filling in the recesses. The mats were successfully applied to reliefs ranging in depth from one fourth to a little over one inch. Absolutely no damage was observed to occur to the originals.

There are several distinct advantages for these casts. They are light, extremely durable, of excellent definition recording faithfully the finer detail, inexpensive, easy to manipulate and safe to use. Positives may be taken from them in plaster, glue and gelatine, or type metal.

F. MARTIN BROWN
ROGER W. WILLIS
FOUNTAIN VALLEY SCHOOL OF COLORADO
COLORADO SPRINGS

SPECIAL ARTICLES

THE OCCURRENCE OF THE PARALYTIC SHELL-FISH POISON IN THE COMMON SAND CRAB[1]

DURING studies of the past five years the paralytic poison which causes sporadic cases of illness and even death in humans after consumption of certain shellfish has been found in the Pacific Coast mussel, *Mytilus californianus,* and in most of the edible clams.[2] Of these, the varieties which are found along the open ocean shore (*Siliqua patula,* razor clam) and near the inlets of bays (*Saxidomus nuttallii,* Washington clam, and *Schizothaerus nuttallii,* horseneck clam), may be dangerously toxic, while *Paphia staminea* (quahog) usually contains less of the poison. *Mytilus edulis* (bay mussel) *Mya arenaria* (softshell clam) and *Ostrea lurida* (the native Pacific oyster), which grow at greater distances from the open ocean, have never yielded toxic extracts. It would be expected that animals which live in close contact with the harmful shellfish might be slightly poisonous, especially since recent experiments have shown that *Mytilus californianus* excretes the poison into the sea water under laboratory conditions. But in none other than bivalves had the toxic substance been demonstrated so far to any considerable amount.

During the recent outbreaks, however, of mussel and clam poisonings—June and July, 1932—tests on the small sand crab *Emerita analoga* (Stimpson) revealed the presence of the paralytic shellfish poison in high concentration in this crustacean. The table shows that animals of any size were poisonous. No difference was found in crabs remote from, or adjoining mussel beds. Analyses of separate parts of the body showed clearly that the poison is concentrated in the intestinal organs, probably the liver, as in the bivalves. The small amount found in other parts, especially in the gonads, must be attributed to dissemination of the poison during the dissection of the small animals. Due to their smaller size the males could not be tested separately as to toxicity of the gonads and the liver; the results in this instance refer to large female crabs. If the liver extracts of *Emerita analoga* from various places are compared with those of the livers of *Mytilus californianus* from near-by mussel beds the fact stands out clearly that both animals are roughly of the same toxicity at the same time. The poison from crabs gives symptoms identical with those from mussel poison when injected intraperitoneally or fed to white mice.[3] The chemical properties likewise are in close agreement; the poison from both animals is readily soluble in water and alcohol, insoluble in ether and chloroform. Boiling with dilute alkali destroys its potency irreversibly, while it is stable in acid solution.

These findings are of significance in various respects. From the practical standpoint of public health it is important to have a readily available

[1] From the George Williams Hooper Foundation, University of California, San Francisco, California.

[2] See preliminary report by K. F. Meyer, *Am. Jour. Pub. Health,* Vol. 21, p. 767, 1931.

[3] M. Prinzmetal, H. Sommer and C. D. Leake, *Jour. Pharmacol.,* 1932, Vol. 46, p. 63.

Date	Locality	Average Lethal Doses of Extracts of *Mytilus californianus* Livers only	*Emerita analoga*		
June 14	San Francisco Beach	.....	Whole animals*	2.5 mg.	
17	" " "	.....	" "	5.0 "	(large specimens)
			" "	2.0 "	(small ")
18	Musselrock (San Mateo County)	0.12 mg.	" "	2.0 "	
21	Salmon Creek (Sonoma County)	10 "	" "	> 60 "	
23	Musselrock	0.2 "	" "	10 "	(large specimens)
			" "	6 "	(medium ")
			" "	6 "	(small ")
26	Muir Beach (Marin County)	0.2 "	" "	2.5 "	(small ")
26	Bolinas Beach (Marin County)	0.15 "	" "	2.2 "	(small ")
29	San Francisco Beach	.....	Eggs	3 doses	eight large females
			Muscles	10 "	
			Viscera	250 "	
July 4	Musselrock	0.2 mg.	Gonads	2.5 mg.	
			Livers	0.6 "	
4	Montara (San Mateo County)	0.2 "	Viscera	0.35 "	
4	Miramar (San Mateo County)	.....	Gonads	1.5 "	
			Livers	0.15 "	
5	Salmon Creek	0.1 mg.	Livers	0.12 "	
19	La Jolla † (San Diego County)	.....	Livers	> 60 "	
20	San Francisco Beach	2.0 mg.	Livers	0.6 "	

* The ratio of weights of liver extract to extract of whole crabs is approximately 1: 10. For a comparison the values given for whole animals have to be divided by 10.

† For this sample I am indebted to Dr. C. E. ZoBell, of the Scripps Institution of Oceanography.

animal the analysis of which will indicate the approach of a "toxic period." Mussels and clams are obtainable only at low tide, during a short time of the day, in limited parts of the coast, while sand crabs can be collected at practically any tide level, every day of the month and at any locality along the coast. Furthermore, the results demonstrate that at some time during the summer months the paralytic shellfish poison is likely to be prevalent in unexpectedly large amounts along the California Coast, since the crab is found in large numbers on any sandy beach. The view held so far that the poison is confined to certain bivalves is no longer tenable. At least this decapod, which, like the mussel, feeds on the plankton of the shore,[4] seems to concentrate or form the poison in the digestive gland. In this connection it is of interest to record that sand crabs kept in aerated sea water in the laboratory for 24 hours gave off measurable amounts of poison into the water. The underlying sand, which had been completely washed free of electrolytes with distilled water, yielded another amount of poison after elution with concentrated salt solution. Further studies of these equilibria and of the toxicity and biology of *Emerita analoga* in conjunction with those on *Mytilus californianus* are expected to be of great help in the elucidation of the intricate problem of mussel poisoning.

[4] F. W. Weymouth and C. H. Richardson, Jr., *Smithson. Miscel. Collect.*, 1912, Vol. 59, No. 7, Publ. 2082.

Summary

The paralytic shellfish poison may be found in a high concentration in the sand crab *Emerita analoga*.

HERMANN SOMMER

THE OCCURRENCE OF MOTTLED TEETH IN IOWA[1]

BLACK and McKay[2] in 1916 were among the first who called attention to mottled teeth in certain areas of this country. Some relationship was suspected between the condition and the drinking water of those regions. Until recently, however, no common characteristic of the waters from affected regions was observed, and, consequently, the causal agent of the disturbance in the structure of the teeth remained unknown.

[1] From the Laboratories of Physiological Chemistry and Physical Chemistry, Iowa State College, Ames, Iowa. Dr. Carl T. Ostrem, Ankeny, Iowa, cooperating.

[2] Black and McKay, *Dental Cosmos*, 58: 129–156, 1916.

Churchill[3] analyzed waters from different sections of this country and found fluorine in a considerable number. Churchill states: "It is well to emphasize the fact that no precise correlation between the fluoride content of these waters and the mottled enamel has been established. All that is shown is the presence of a hitherto unsuspected common constituent of the waters from endemic areas. However, it is of interest to note that apparently the relative severity of the defect in these various areas seems to follow the fluoride concentration."

Smith, Lantz and Smith,[4] of the University of Arizona, have shown that the tooth defect is due to fluorides in the drinking water; they have analyzed the fluoride content of waters in endemic areas and found it to be high. Furthermore, they have produced an analogous condition in rats by feeding small amounts of fluorides. McCollum, Simmonds, Becker and Bunting[5] and Schulz and Lamb[6] observed some years ago that the feeding of sodium fluoride had a marked effect on metabolism and caused changes in the teeth of rats comparable to those we now recognize as characteristic of mottled teeth in human beings.

Dr. Carl T. Ostrem, of Ankeny, Polk County, Iowa, recently called the attention of Professor V. E. Nelson, of Iowa State College, to a condition existing in that region which corresponds exactly to the description of mottled teeth. How extensive this area is we do not know. However, a large number of the children of this vicinity have mottled teeth. It is possible that the trouble began after the sinking of deep wells in this region and that the condition did not occur while shallow well water was used. This is substantiated by the fact that the cases so far noted have occurred in children born at approximately the time when the deep wells were installed.

Professor Nelson, Mr. Greenwood and Mr. Wilhelm have undertaken a study of this problem in this locality and, although their data thus far are not extensive, they are convinced the water in this area contains fluorides and that the mottled teeth are due to this.

Two samples of drinking water from deep wells were analyzed qualitatively by the spectrographic method, employing the carbon arc, and the characteristic calcium fluoride band was present in each spectrum. One sample of water was obtained in the town of Ankeny and the other from a farm in the neighborhood. A sample of shallow well water from this same region gave no qualitative test for fluorine. Neither did the water from the college supply give a test for fluorine. The City of Ames is approximately 20 miles north of Ankeny. The two samples of drinking water from deep wells were analyzed quantitatively for fluorine by the Churchill modification of the Fairchild method[3] and shown to contain 10 and 15 parts of fluorine per million respectively. Fluorine is a difficult element to determine, especially in small amounts. We expect to improve our methods and technique and perhaps will have to modify our values somewhat after such is done, and after large numbers of samples are analyzed. However, mottled teeth occur in the community referred to, and this presumably is due to the fluorides in the water. Although our experiments with rats are not concluded by any means, still they seem to indicate thus far that consumption of the water causes the characteristic changes in the teeth resulting from fluoride ingestion. H. V. Smith and M. C. Smith,[7] of the University of Arizona, in their recent publication show the latest distribution of mottled teeth in this country. Iowa is one of the states in which they say mottled teeth have not so far been reported. We expect to extend this work to different sections of the state of Iowa.

CARL T. OSTREM
VICTOR E. NELSON
D. A. GREENWOOD
H. A. WILHELM

[3] H. V. Churchill, *Jour. Ind. and Eng. Chem.*, 23: 996–98, 1931.

[4] Smith, Lantz and Smith, "Dental Survey," April, 1932. *Technical Bull.* No. 32, Agricultural Experiment Station, University of Arizona.

[5] McCollum, Simmonds, Becker and Bunting, *Jour. Biol. Chem.*, 63: 553–62, 1925.

[6] Schulz and Lamb, SCIENCE, 61: 93–94, 1925.

[7] Smith and Smith, *Technical Bull.* No. 43, 1932. Agricultural Experiment Station, University of Arizona.

BOOKS RECEIVED

CLARK, GEORGE L. *Applied X-Rays.* Pp. xiv + 470. 230 figures. McGraw Hill. $5.00.

FREUDENBERG, K. *Stereochemie. 5. Lieferung.* Pp. 153. Leipzig und Wien. Franz Deuticke. M. 18.

GILBERT, NORMAN E. *Electricity and Magnetism.* Pp. xvi + 548. 388 figures. Macmillan. $4.50.

HARDY, JAMES G. *A Short Course in Trigonometry.* Pp. ix + 143. Figures. Tables. Macmillan. $2.25.

HENDERSON, JUNIUS and ELBERTA L. CRAIG. *Economic Mammalogy.* Pp. x + 397. Thomas. $4.50.

HITCHCOCK, DAVID I. *Practical Chemistry for Students of Biology and Medicine.* Pp. xi + 182. 26 figures. Thomas. $2.75.

JOHANNSEN, ALBERT. *A Descriptive Petrography of the Igneous Rocks.* Vol. II. Pp. xxxi + 421. 119 figures. University of Chicago Press. $5.50.

KIRBY, RICHARD S. and PHILIP G. LAURSON. *The Early Years of Modern Civil Engineering.* Pp. xvi + 324. Illustrated. Yale University Press. $4.00.

MARSHALL, F. H. and E. T. HALNAN. *Physiology of Farm Animals.* Pp. xi + 366. 117 figures. Cambridge University Press. $3.25.

MARTIN, THOMAS. *Faraday's Diary.* Vol. I: September, 1820—June 11, 1832. Pp. xxiii + 430. Illustrated. G. Bell & Sons, London.

RUCH, G. M. and F. B. KNIGHT. *Standard Service Algebra.* Pp. xiv + 528. Illustrated. Scott, Foresman. $1.32.